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[Founded in 1849 as the "Journal of Gas Lighting."]

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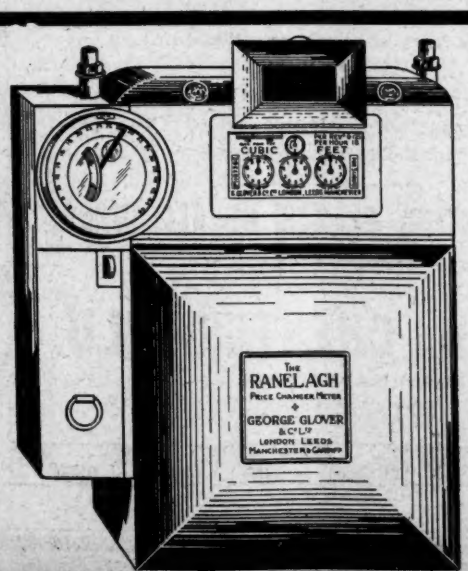

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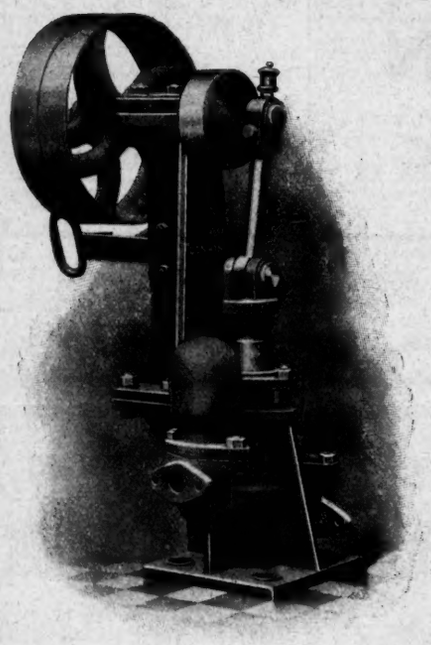

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EDITORIAL NOTES.

At Last a Ballot of the Miners.

An end has been reached to the coal-mining conferences, bargainings, correspondence, explanations, and the confusing mass of statistical and other disagreement; and a ballot of the miners themselves is to be taken on the offer of the owners which may be regarded as their final one. The decision as to the taking of a ballot was arrived at on Friday morning last at a meeting of the district delegates with the Executive of the Miners' Federation. The ballot takes place to-day; and the returns are to be at the headquarters of the Federation on Friday morning. This is all good news. The country has waited for it a long time, and has put up with a great deal of inconvenience and immeasurable loss while good sense has been making the effort to assert itself in the counsels of the Miners' Federation, although the owners themselves are not altogether blameless so far as their original offers are concerned. A ballot of the men ought to have been taken weeks ago; and it would have been had not the extremist element in the sheaf of officials and delegates in the Federation been allowed to rule and exercise an arbitrary and reckless dictation. But for them a settlement on the lines of those now before us could have been realized some time ago; and the country and the miners themselves could have been saved much of the aggregate of the deplorable issues of the imbroglio in which we have been, and from the consequences of which we shall not soon escape. Even at the meeting of the delegates last Friday, the extremists tried to obtain the rejection of terms which are fair and reasonable both for a temporary settlement, and as a basis for a lasting adjustment of the relations between employers and employees in the coal-fields. As a solatium to the extremists, on the ballot-paper the first question the miners are asked (which should now have been the alternative, and taken second place to the real matter of importance to the men—the terms offered) is whether they are in favour of fighting on for the principle of the National Wages Board and a national pool; but it is accompanied by the warning that this would mean the loss of the Government subsidy of £10,000,000 for wages, the offer of which will expire on Saturday if a settlement is not achieved by that time. Although on the ballot-paper there is no word of guidance for the miners—showing the division of opinion that still exists among the members of the Executives of the Federation and the District Unions—they will before they put their crosses on the ballot-papers look very carefully at that goodly sum of £10,000,000, as well as at the temporary and permanent terms which will maintain them as one of the best paid classes of workers in the country. There is the liveliest hope that, now the matter is to be left to the vote of the men themselves, all will go well, and that the extremists' policy will fall before the absence of the requisite two-thirds majority that is necessary to continue the strike.

The terms submitted to the miners come under two heads—a temporary period, and a permanent scheme. With regard to the former, the first reduction of wages is not to exceed 2s. per shift for all workers of 16 years of age and upwards, and 1s. per shift for workers below 16 years. There is to be no other reduction until Aug. 1. Any further reduction after Aug. 1 is to be agreed mutually until the Government grant is exhausted. The temporary agreement will come to an end as soon as the Government grant has been distributed. But a point the ballot-paper does not emphasize is that the owners will forego for three months their profits in any district in which the standard wage cannot be maintained without assistance from the Government. Nor does it mention that the initial wages cut is very small, having regard to the economic position of the industry, and the cost that will have to be incurred to bring the collieries back to their full productive capacity. As to the permanent scheme, the owners propose the formation of a National Board for the guidance of the District Boards, to be composed of equal numbers of representatives of both sides, with an independent chairman. The parties have already agreed to the principle that profits shall only be a fixed percentage of wages paid. The Board will determine the amount of the percentage of profits to wages, and will decide the amount of the new standard. In this connection, the owners have offered as a standard wage the total wage paid in July, 1914, with district additions to the standard, *plus* a percentage for pieceworkers caused by the reduction of hours from eight to seven, and a minimum percentage to continue until June, 1922. The Board will also fix the items of cost which must be taken into account by the district auditors when ascertaining the district revenue. Wages during the permanent scheme are to be based upon the capacity of each district to pay. In the event of a low-paid day worker receiving a rate which does not provide him with a subsistence wage, the District Board will fix the rate which will secure it for that workman. The decision of the National Board as to the permanent scheme is to be binding for the period of twelve months, and is to be subject to three months' notice on either side. Those are the terms on which the ballot is taking place to-day.

Naturally the higher the production during the temporary scheme, the longer will the Government grant hold out; and, under the permanent scheme, the higher the production, the lower will be the costs, and so the greater, according to trading conditions, should be the profits for division under the percentage profit-sharing scheme. Machinery is to be put into operation to investigate the question of output; and the application of profit-sharing to the industry is regarded as a great step forward in the relations between employer and employed. If it becomes an accomplished fact, it is believed that it will have a very important influence throughout the whole of the industries of the country. Under the profit-sharing scheme, as the miners will become co-partners in the industry, it will, of course, be to their interest to bring it back to a condition of prosperity. A subject which proved a very thorny one during the week was that of the economic grouping of the coal-fields into wage areas; but this, we believe, has been amicably settled.

All that has to be done now is to wait for the decision which will either bring the pits into an active state again, or continue for a time longer a state of things that has been so disastrous to the country, and to the miners themselves. They have lost more pounds in wages than the country has lost in tons of coal. A production of only 4,000,000 tons a week (it averaged over 5,500,000 tons in 1913) means in eleven weeks 44,000,000 tons of output lost; and £1 per ton in wages (their earnings have been much more than that) would represent an equivalent number of pounds in money. Their unions are now destitute of funds, and are in debt. Financially, they are in a corner; but no advantage has been taken of this. They have dealt the country a blow recovery from which will take a long time. But the terms before the miners contain no trace of animosity. Confidence is on the side of the miners' acceptance of the terms, though the extremists are busy in the districts. The men have had enough idleness, and their people more than enough deprivation. There should be, if the ballot goes as is anticipated, an almost immediate return to the pits; and when once more in working order—some will never be restored to that

condition—there should be a period of real hard work. But at first the stream of supply will be of small volume; and the whole country is waiting to show its power of coal absorption. It is not only a question of satisfying current requirements; the time has come for commencing to restock for next winter.

Thermal Efficiency of the Blue Water-Gas Process.

FOLLOWING Sir George Beilby's report on the steaming of charges in the setting of continuous vertical retorts at the Fuel Research Station, we to-day publish the first instalment of the sixth report of the Research Sub-Committee of the Gas Investigation Committee of the Institution of Gas Engineers and the Leeds University. The fifth report will be dealt with later, as certain diagrams are required to complete it. The report before us is by Dr. A. Parker, the Research Chemist, to whom has been entrusted the work of investigating the comparative economies in production of different grades of gas. The previous report by Dr. Parker, it will be remembered, described the investigation of the working results of the continuous vertical retorts at Uddingston; this report treats in the same manner the investigation of the working and results of the Humphreys and Glasgow blue water-gas installation at the Adderley Street Gas-Works of the Birmingham Corporation, the actual control of the plant being in the hands of Mr. G. A. Bamber, Engineer of the station. The industry is much indebted to the Birmingham Gas Committee for the very substantial assistance that they and their staff have rendered, and delight in rendering, in these researches, conducted under actual working conditions. But, of course, the results of researches made in this way are always subject to the conditions of the operation of the particular plant, and can only be utilized generally in their application to other plants. In this case, as at Uddingston, there is considerable value in the recorded results, because Dr. Parker has set out in very full detail the data contributing to the results, and so one can follow throughout the values of the many factors that have to be taken into consideration. The work has been exceedingly well done; and the investigation may be taken as complementary to the Uddingston steaming inquiry.

In connection with blue water-gas plants, we have not hitherto had any very reliable efficiency tests, other than those made by Mr. E. G. Stewart. For the most part, the efficiencies previously published appear to have erred on the high side—in some cases, due to the fact that the figures do not include the fuel required for the generation of steam and for driving the blower. In such instances, efficiencies have been mentioned as high as 65·6 to 76·6 p.ct. But even where allowances have been made for the fuel needed for the steam purposes, the results have shown an efficiency of somewhere between 53 and 59 p.ct. These, too, may be taken to have been derived from special runs made for the express purpose of testing. But the tests for which Dr. Parker is responsible have been made under ordinary working conditions. As a matter of fact, the efficiency results found by both Dr. Parker at Birmingham, and Mr. Stewart some time since at one of the stations of the Gas Light and Coke Company, are not very far removed the one from the other. In Mr. Stewart's tests, he obtained a production efficiency for blue water gas of 58 p.ct., which was reduced to 42 p.ct. after allowing 9·5 lbs. of fuel per 1000 c.ft. of gas made to supply steam to the generator and for driving the blower. In the case of Dr. Parker's tests at Adderley Street, he realized in three tests, when the fuel for the steam for the generator and turbine was not taken into account, 55·2 p.ct., 55·9 p.ct., and 56·5 p.ct.; the average of these efficiencies being 55·9 p.ct., which compares with Mr. Stewart's 58 p.ct. When the fuel for the steam for the generators and turbine was taken into account, Dr. Parker found efficiencies in the three tests of, respectively, 45·8 p.ct., 46·7 p.ct., and 46·4 p.ct.; the average being 46·3 p.ct., which compares with Mr. Stewart's 42 p.ct. In considering tests relating to water-gas plant efficiencies, the importance of ensuring that an allowance has been made for the fuel required for generating steam and for driving the blower is manifest from the differences in these figures. It should be pointed out that in Dr. Parker's results, the fuel required to raise the steam for the generator and the turbine is calculated on a 70 p.ct. boiler efficiency. Though in the tests referred to in the report the object was to ascertain the efficiency of the blue water-gas process as ordinarily practised when reasonable care is exercised in controlling the conditions, and not to determine the maximum efficiency which may be obtained over a short-period test-run only, it will be noticed from the report that considerable care was taken to ensure accuracy of measurements, weighings, and sampling of the coke, gases, ashes, clinker, and dust, as well as in the measurement of pressures, temperatures, &c.

In the Uddingston steaming tests, last year's report shows that the thermal efficiency of gas production rose from 54·4 p.ct. in the first test without steaming to 62·1 p.ct. in the fourth test with steaming. This shows in which direction—steaming verticals or separate water-gas making—the greater thermal efficiency is found; but, of course, from the gas maker's economic standpoint, thermal efficiency is not everything. Dr. Parker, in the present report, institutes a further interesting comparison between the efficiencies of the blue water-gas plant at Adderley Street and the Uddingston steaming, in connection with which he makes the point (also referred to in Sir George Beilby's report), that the heat losses in the process of continuous carbonization are greater without steaming than with steaming. After applying the necessary corrections for the differences in carbonization losses, the calculated thermal efficiencies of the extra gas resulting from steaming in four of the Uddingston tests are 68·5 p.ct., 64·6 p.ct., 64·7 p.ct., and 57·6 p.ct. It is important to note that these efficiencies are all higher than those realized in the three tests on the Adderley Street water-gas plant, even when no allowance is made for fuel for raising steam. This, of course, is due to the fact that some of the heat of the incandescent coke is utilized in the making of the water gas when steaming the charges in vertical retorts. We hope, when conditions allow, that tests will be made to ascertain what thermal efficiency difference is effected when incandescent coke is transferred immediately from the coal-gas retorts into a water-gas generator, as is now done with one plant at the Brentford gas-works.

The tabulated heat-balances are a feature of the report. They show where the heat losses occur in water-gas making, and therefore where possible economies might be effected. As Dr. Parker points out, the greatest loss is represented by the potential heat of the "blow" gas, which accounts for approximately 20 p.ct. of the heat supplied. The average amount of heat lost as sensible heat in the water gas, "blow" gas, and undecomposed steam is approximately 8·6 p.ct. of the heat supplied. The question arises as to the utilization of these heat losses; and waste-heat boilers are suggested. Here calculations and assumptions are adopted by Dr. Parker, seeing that the Adderley Street plant is not equipped with a waste-heat boiler. As a result, he finds that the heat per 1000 c.ft. of water gas made available for use in a waste-heat boiler would raise approximately 69 lbs., 74 lbs., and 78 lbs. of steam on the basis of a 70 p.ct. boiler efficiency, which amounts would be sufficient to provide the steam for the generator and to drive the blower. At Brentford [see "JOURNAL" for April 20], they are actually doing better than this, and have a surplus of steam. However, on Dr. Parker's calculations, using a waste-heat boiler, the average efficiency of production of water gas, taking his Birmingham tests, and the amounts and composition of blow gas under the conditions there, would be 55·9 p.ct., which is precisely the same as the efficiency when the fuel for the generator and the turbine was not taken into account. Of course, the figures cannot be applied to any other conditions under which water-gas generators may be operating. The point is specially emphasized in the report that before reliable conclusions can be drawn regarding the advantages or disadvantages resulting from waste-heat boilers in continuous vertical retort-settings or blue water-gas plants, actual working tests are required. But practical experience so far indicates advantages of a very useful economic order, though Sir George Beilby and his staff, so far as steaming in vertical retorts goes, is rather inclined to prefer the utilization of the waste heat for preheating the air for combustion purposes, so producing in this way a saving of fuel.

We have confined this reference to the report to the thermal efficiency aspect; but students of the document will find the working results set out in very great detail. We should like to acknowledge the completeness of the data, which, in our experience, have never been presented with greater clearness nor with such fulness. There is not a component that is superfluous; interest and value are in every line.

Coal Storage and Strikes.

THE national coal strike has lasted now approximately eleven weeks; and many gas-works have been, and are, in a parlous condition in regard to coal supplies—despite the influx of imported coal, some of which is of a quality diametrically opposed to its cost. It is, therefore, opportune for gas engineers to consider the question of what will be an appropriate measure of storage of coal for the future. The old formula regarding stocks must to-day be regarded as obsolete. Developments in the labour situation have destroyed the conditions on which the formula was originally based; and it has to be considered now in relation to current conditions. This was the principal topic dealt with by Mr. R. J. Philp, of North Berwick, in his Presidential Address last week to the Waverley Association of Gas Managers. He suggests that, if the old rule of a six weeks' supply was correct in circumstances no longer existent, then the new lines of labour policy and action demand that a storage nearer a three months' supply should be substituted. Of course, the chief objection to the extended provision of coal storage is the financial one. It means that capital charges, depreciation, and the cost of handling are all increased in proportion to the greater magnitude of the storage. But, on the other hand, when increased risks arise, an increased insurance must be provided, in order to safeguard the primary object of a gas undertaking, which is to supply gas.

These increased risks are very manifest when we consider that nowadays, as Mr. Philp points out, labour questions are dealt with on a national basis, and not on a sectional one. This applies, of course, not only to the coal miners, but to the railway men and transport workers, with whom, in conjunction with the coal miners, the gas industry is particularly concerned. At any time, there is the risk that something may happen which will cause the railwaymen to strike throughout the country; and the same applies to the transport workers. It is quite feasible, too, that at some time or other they would act in unison in the matter of a strike, in order to enforce claims in which one or other or both are concerned. There is the risk, although we know, as recent events have proved, that it is very difficult to get large bodies of men with dissimilar interests to act in harmony. This has been illustrated more than once in connection with the present strike. In the first place, there was the threat of the National Union of Railwaymen and the Transport Workers' Federation ordering their members to leave work in order to support the miners. This threat collapsed. Then, again, we had the same two bodies placing an embargo upon the handling of imported coal. Here once more there was a collapse, owing to the unwillingness on the part of a large majority of the rank-and-file of the Unions to do anything that would make more poignant the already acute miseries of their country. Nevertheless, as will be seen from these incidents, we have been on the brink of the fulfilment of very grave additional risks to the country at large; and these are risks which, in addition to the miners' ability to hold out for three months, necessitate very serious and broad attention being given to the question of the provision of an adequate coal stock. New ideas must, therefore, be formed regarding the financial aspects of a storage sufficient to guard against all possible abnormal occurrences, which, as things have developed, may materialize much more frequently, and with greater severity and extension, than anything that we have previously encountered or have even conceived.

There is, however, an aspect of the question which Mr. Philp does not mention. It is this, that some gas undertakings possess manufacturing resources which to some extent curtail what would be the maximum need for coal storage in the case of those gas undertakings dependent exclusively on the making of coal gas. The present strike has accentuated this point. In the recent instructions of the Mines Department of the Board of Trade regarding the manufacture of gas, the gas industry was explicitly told that during the strike all undertakings having water-gas plant must use it to the fullest extent, and only make coal gas to the quantity needful to fill the requirements of their customers. Those gas undertakings possessing water-gas plants have in them something which will in a material way counteract in the future the need for the extra storage which the developments of labour have brought upon the industry. The same, of course, applies to complete gasification plants. During the present strike, there have been gas undertakings in the country that have sent out in the bulk of their gas 50 to 60 p.ct. of water gas. The ability to do this has a tremendous effect on the question of coal storage. Those gas undertakings, too, have done something particularly beneficial to the country at large, and to those gas undertakings that are entirely dependent upon coal for the provision of gas for their districts. In the address of the President of the Institution of Gas Engineers (Mr. Thomas Goulden, M.Inst.C.E.), published in the "JOURNAL" last week, he pointed out how, at one of the stations of the Gas Light and Coke Company during the present emergency, no less than 48½ p.ct. of water gas has been distributed (using 1·1 gallons of oil per 1000 c.ft. made), which gave, in the mixture of coal and water gas, no less than 111 therms per ton of coal carbonized. This 111 therms at this one station is a considerable departure from the normal practices of the Company; and it means considerably more potential heat value through the gas-mains per ton of coal treated—to the advantage of the consumers and of the Company's coal stocks. Such gas-making resources, diminishing the need for excessive coal storage, are worth a considerable capital sum, seeing that these same resources are also valuable in their influence in assisting in the dilution of coal gas, so producing more therms per ton of coal handled, as well as enabling the peaks of demand to be safely and readily negotiated. Our electrical friends are likewise considering, in view of the lessons of the present strike, the necessity for enlarging their coal storage for the protection of their business during industrial upheavals. In some instances, they are talking of three and four months', and even six months' supplies; but the further lessons they have had from the utilization of fuel oil and coke have turned their attention to the question of the propriety of having more strings to their steam-raising "bow" than the single one of coal. Still later, professional interest, looking to the future, is inquiring whether it will not be better also to utilize in part internal combustion engines using gas or oil for electricity generation. In the former case, advocacy tends to the use of producer plant in connection with the engines, and the employment of coke as the fuel for the production of the gas.

These are all points that bear upon the question raised by Mr. Philp in his address at the meeting of the Waverley Association. It is quite clear that gas engineers will have to legislate betimes for industrial crises in the future, and apply to them the measure of present experiences, together with a good factor of safety for any growth in organized labour policy. But no universal rule can be applied as to what is a proper storage provision. Conditions vary; and water-gas and complete gasification plants are among the conditions that are effective items in varying the storage necessary for due protection in the altered circumstances of labour organization and policy, which is in these days so largely framed and directed by an element with extreme tendencies and ideals.

Bearing upon the question of increasing the therms per ton of coal handled during a time of stress for fuel such as we are now experiencing, is Mr. Philp's statement that during the strike the consumption of gas in North Berwick has increased by no less than 25 p.ct. This tells a tale. He is fortunate in having been able to meet such a demand. It only shows the growing reliance of the public upon gas for heating purposes. We undertake to say there are few (if any) electricity undertakings which, on the domestic side of their business, have experienced any pressure beyond the normal for electrical energy for heating purposes—such as gas suppliers have done, and so much so that pressures in the distribution systems have had to be reduced, and in some cases the supply discontinued during part of the day, in order to counteract the effects of demand, and make the stores of manufacturing materials spin-out as long and as far as possible.

We sympathize with Mr. Philp's protest against the carrying of English coke across the Border during the days when the supply was plentiful and embarrassing; and so making worse the markets for the output of the Scotch gas-works. There is nothing of this now. Coke is a fuel much sought after in the absence of coal; and there are no surplus stocks, and there is no difficulty now in disposing of all production. We should be glad to feel that there will be no occasion for similar complaint again. But anyway it is to be hoped that with the revival of industry, with the experience gained of late with coke for steam-raising, and with the gas industry supplying mixed gas to a much larger

extent, surplus coke, even when coal is once more abundant and cheaper, will be a diminishing quantity. The address also emphasized the point that with dear coal, and more costly plant and labour, the need has increased for reducing unaccounted-for gas to the lowest possible point. Each therm that is lost now is more valuable than the equivalent number of cubic feet before the war, and each therm that is safely transmitted from the works to a point of consumption is in these times, for a nation deprived of its main source of fuel, of greater intrinsic value than ever.

A Recording Calorimeter on Probation.

THE Gas Referees have not yet prescribed a recording calorimeter or calorimeters for use in the testing of gas under the Gas Regulation Act; but an interesting piece of information comes through which shows that they have still open minds on the subject. There are several competitors for official favour, with attached recommendation in various degrees of accuracy. But with all the good report that we have as to individual accuracy, experience assures us that time alone on continuous working and under different conditions is the one safe test as to perfect reliability. But it seems to us to-day that all calorimetric candidates to favour may hope; for it looks as though if any instrument can justify its existence by proof of continuous accuracy, the Gas Referees will be prepared, after limited certification, to continue it. That is the interpretation we put upon a statement towards the end of an article in another column describing the "Fairweather" recording calorimeter. The statement is to the effect that the Gas Referees are prepared to give a limited certification of the calorimeter for official testings of the gas supplied by the Brentford Gas Company; but this certification is liable to cancellation at the end of a year if the instrument proves unsatisfactory for official purposes. So far it is giving such a good account of itself at Brentford that there is every prospect it will completely justify its existence. Recording instruments have come before us with a proved accuracy within 1, 1½, and 2 p.ct. variation from the tests made by the standard calorimeter. These are close workings; but here the "Fairweather" recording calorimeter claims, on a nine months' continuous run at Brentford, with carefully made check tests, an accuracy within ½ p.ct. That is bringing accuracy in such a matter as this to a very fine point indeed. This, however, is a test made on the gas of one company; and during the period the gas on which the test was made may have been fairly constant in all respects. Will this instrument tested under the variations in different gas undertakings of specific gravity and other conditions, and the extremes of temperature and atmospheric pressure met with in practice, maintain, wherever used, an accuracy drawn to such a fine point as ½ p.ct. ? Time alone can tell us; but there is confidence in the interested quarters. A feature of this new continuous total-heat recorder is that the calorimeter itself is of the Boys type, modified to accommodate it to the invention, which provides not only the continuous record, but applies correction for temperature and atmospheric conditions by the automatic regulation of the water supply—the rate of the supply of gas being maintained constant by a clock-driven meter. The calorific value of the gas is determined directly from the rise in temperature of the water passing through the calorimeter. Moreover, the calorimeter is fitted in such a way that an ordinary test can be made to check the accuracy of the record without interfering with the continuous working of the instrument. The details of the novel features of the invention will be found in the descriptive article that appears in this week's issue, as well as in the abstract of the patent specification published last week. Gas engineers are all beginning now to think in terms of declared calorific value and therms, and are investigating to determine how near they can work to the declared value to maintain their legal obligations at the district extremes. The accuracy and reliability of the recording calorimeter will have a part in this determination, as well as in protecting the interests of both gas undertaking and consumers. Therefore, the more experience we have published as to the working of the different claimants and under different conditions, the better. We regret that Mr. Fairweather is not with us to-day to see whether or not the ingenuity that is found in his invention will succeed in gaining official endorsement by continued certification after the probation period at Brentford. The certification by the Gas Referees for a year is a point in its favour.

What of the Future?

THERE is an interesting paragraph in the report the Gas Committee presented to the Birmingham City Council last week, which well illustrates the uncertainty of the present position, the impossibility of prognosticating the course of future events in regard to prices, and yet the great hope that exists that before many months are over relief will be obtained. The Birmingham Gas Committee are only voicing what all other administrators in the gas industry feel; but, although everything having an economic bearing is in perfect chaos at the moment, in every quarter of the industry there is found a quiet confidence regarding the future. At Birmingham, the Committee are anticipating the necessity for having again to increase the price of gas; but they are refraining from making a recommendation until things get more stabilized. It would be very foolish to raise the price with the existing extraordinary conditions as the basis. There is no doubt that money is in some cases being lost at the present time (at the moment expenditure is exceeding income at Birmingham), owing to the fearfully high prices which are being paid for coal. On the other hand, taking secondary products together, there can be little or no complaint as to the total income from them; and this will go to counterbalance the high prices that are being paid for imported coal, and therefore for the coke which is made from that coal, and used for water-gas production. Again, where oil is employed, to-day's market price is lower, although this is not likely to have any immediate effect, owing to the dearer priced oil in store. The strike and these and other conditions render gas administrators totally incapable of visualizing what the circumstances will be, even may be, in a few weeks, and so of forming any reliable estimate as to the future—in short, while economic conditions are shifting from day to day, practically nothing can be done that can be regarded as definite. If, in the wisdom of gas administrators, it is considered imperative to raise the price of gas before matters become more stabilized, it is not unreasonable to believe that this will only be a temporary need pending affairs becoming more stabilized. There is now a fair prospect that the price of coal will be reduced. Only 1s. per ton reduction in the case of Birmingham would mean £40,000 a year. In the case of the Gas Light and Coke Company, it would make a difference (without considering the lower price of oil) of nearly £114,000 on the 1920 coal consumption; in the case of the South Metropolitan Company, it would represent well over £60,000. On the coal carbonized by the statutory gas undertakings of the United Kingdom, the 1s. would mean between £800,000 and £900,000. We are looking for considerably more than 1s. per ton reduction; but by the number of shillings reduction, the foregoing figures will have to be multiplied, with a deduction for the certain *per contra* that will be supplied by the lower values of secondary products. The industry, too, ought soon to be getting beyond the heavy costs for repairs and replacements that have had to be incurred to make up for the big leeway in these respects suffered during the years of war. And as the Birmingham Gas Committee hint, there should be some savings in respect of wages and salaries. Therefore, although it is impossible to say absolutely what will happen, although it may be necessary owing to the extra burdens imposed by the coal strike to raise the price of gas again, there is good ground for the belief that this will be of only short duration; and then will begin those recessions of prices which will make for progress and increasing stability in the industry. Notwithstanding that we are suffering heavily from an industrial eruption at the present time, the outlook is brightening.

Fuel Imports and other Bearings of the Strike.

The severe blow that the coal strike has given to the trade of the country is disclosed by the Board of Trade returns for May. The values of imports and exports have tumbled down by millions. Every page of the returns bears witness to the paralysis of trade and industry. It is a disaster of immeasurable extent in view of the ramifications of the effects. Instead of being big exporters of fuel, we are to-day importers. During the month of May, this country imported 450,162 tons of coal, which is a very small proportion of a normal month's output and consumption in this country. This imported coal is credited with having had a value of £1,533,459, which averages £3 8s. 1½d. per ton. It may be expected that unless work at the mines is quickly resumed, the

month of June will show a still larger quantity of coal brought in from abroad, for the importers have got into good stride now. During the month, too, 90 million gallons of petroleum were imported, or 21 million gallons more than in May, 1920. In the first five months of the year, this country landed 428 million gallons of oil—mainly fuel oil and motor spirit. The oil people have been making hay while the miners have been idle.

Direct Cost to the Country.

The country is a heavy sufferer over the gamble for attempting to maintain the miners' wages beyond what the industry can afford to pay, and trying to create a national "pool." The effect on the railways during April—not due to the carriage of coal only, but to the reduction of manufactures owing partly to the stoppage of coal supply—is that the expenditure exceeded the revenue by £5,858,460, making, with the State guarantee of £3,686,000, a total State liability for the month of £9,544 460. To meet civil emergency expenditure arising out of the coal stoppage, supplementary estimates of £15,260,700 have just been presented to Parliament. This total comprises £9,000,000 for the railways and £6,260,700 for emergency services. Under this the main item is £6,000,000 expended on the purchase and importation of foreign coal on Government account for use in the maintenance of essential public services. The details are: Food transport organizations, £100,000; general transport organizations and miscellaneous services, £120,000; coal supply organization, £40,000; purchase and importation of coal, £6,000,000; and loan to South Staffs Mines Drainage Commission, £700—total, £6,260,700. For the purchase of coal from other countries £2,450,000 has been advanced from the Civil Contingencies Fund; and this sum will be repaid out of the vote. Receipts from the sale of the coal will go direct to the Exchequer.

Safeguarding Industries.

The Safeguarding of Industries Bill has been read a second time in the House of Commons. The discussion upon it was long and animated; and the speeches showed a very marked division of opinion on the subject—a division of opinion not only political in character, but industrial. Some thought it a pragmatic measure which ought to have no existence at all; others opposed it with speeches obviously founded upon a pure self-interest; and others supported it for the same reason. A large number of members have no personal opinion on the subject; and those who are in this category and are followers of the Government voted for the measure, and so the second reading was carried. One point that, in the discussion of the economic aspects of the Bill, appears to be largely overlooked is that the neglect of key industries in this country proved nearly fatal to us at the beginning of the war, and no doubt prolonged the mighty struggle. This is a point which should be kept well to the fore. Another is that there are industries of grave importance to the country in war time which now require an amount of protection for a period to get them well rooted. Another thing needed is a sound discrimination as to industries which it is in the interests of the country to protect. A good deal of looseness and elasticity has been introduced here. Had there been better discrimination, there would have been less controversy. It is also as well to keep in view the fact that we are not assured against wars in the future, and that it is wise to make our own country as self-contained and productive as possible. The political aspects of the matter are no concern of ours; the country's interests are the concern of all of us.

Building Blocks from Clinkers.—A Brest industry, which suspended operations during the war, but which has now re-started working, is that of the manufacture of building blocks that are gaining widespread usage in certain kinds of building construction in the district. The blocks are made in moulds, the materials used being sand, lime, and cement, with a base of crushed coal clinkers. The lower grade of blocks also contain some coal cinders. These blocks are made in several sizes. The blocks have the advantage over brick for building material in that they are cheaper and facilitate quick construction. However, the outstanding advantage of the clinker block over the brick in the Brest district, writes the United States Consul at that port, is the capacity of the former to withstand the great humidity of the climate there, which causes brick walls to drip water in the interior of houses.

PERSONAL.

The Doncaster Gas Committee recommend the appointment of Mr. STEWART PACEY, of that town, as Assistant Gas Manager to the Corporation—in succession to Mr. W. W. BALL, who resigned—at a salary of £300 per annum, *plus* bonuses, subject to his undertaking to remain in the service for at least twelve months. The Town Council, having given general approval to the appointment, referred the matter back in order that the question of salary might be made quite clear.

Captain GORDON HELPS, R.F.A., B.Sc., son of Mr. William D. Helps, of Leeds, has passed by examination his Assoc. M. Inst. C.E. When the war broke out in 1914, he was offered, and accepted, a Commission in the R.F.A., and was gazetted Second Lieutenant on Aug. 12 of that year. He spent most of his time in the north of France, and was one of the first to be demobilized on the armistice, in order to continue his studies for the degree of B.Sc., which he secured in the autumn of 1919. Since then he has been with Messrs. Humphreys and Glasgow.

The Workmen's Section of the South Metropolitan Gas Company's Co-Partnership Committee presented their ex-Chairman, Mr. W. BEARD, with a handsome clock, as a mark of esteem, and in recognition of his long and valuable services on the Committee, from which he has retired on taking up the position of Employees' Director. Mr. F. Whitehead, in making the presentation, referred to Mr. Beard's work, and to the progress made during the last few years in developing the usefulness of the Co-Partnership Committee as an integral part of the Company's organization.

Mr. R. M. SIMPSON, the Manager of the Buckie Gas-Works, has been appointed Gas Manager to the Denny and Dunipace Town Council.

Mr. H. TALBOT has been appointed Assistant Manager to the Welsbach Light Company, Ltd., and not General Manager, as stated in our issue of the 8th inst.

OBITUARY.

The death took place at Auckland (N.Z.) on April 18, of Mr. HENRY ATKINSON, an old colonist and a highly-esteemed citizen. Deceased, who had reached the advanced age of 84 years, was born in this country, at Windermere. He arrived in New Zealand in 1863, to supervise the erection of a plant for the Auckland Gas Company. Two years later he was appointed Manager of the Company's works, and occupied this position for 35 years. Prior to leaving England for New Zealand, Mr. Atkinson had erected large engineering plants on the Continent and also in connection with the Glasgow water-works. In New Zealand he erected gas-works at Waitara, New Plymouth, Gisborne, Whangarei, Thames, Devonport, Northcote, Hawera, Paeroa, Hamilton, Pahiatua, and Balclutha. He did a great deal for the city of Auckland, and will be keenly missed.

ELECTRICITY SUPPLY MEMORANDA.

THE electricity industry has never been good at making consolidated and harmonious movements. The old trait continues. It is markedly illustrated in the chaotic position into which joint electricity authority schemes have fallen supplemented by the little favourable interest that is being shown in the Electricity Supply Bill (No. 2). The greater interest in both the schemes and the Bill is displayed by the opponents. The roseate hues that made at first so attractive the plans for the rejuvenation of the electricity supply industry have faded, and something much soiled has taken their place. Belief in the efficiency for destined purpose has shrunk away almost to a shadow. When investigation is made as to why these things are, why the change has come about, it appears to be tolerably clear that it is largely due to: (1) The fact that there is municipal management of such a large part of the electricity supply industry, and that the major number of the authorities are unwilling to sacrifice their electrical autonomy; (2) that municipal administration, owing to the extent of the indebtedness of such bodies and the height of the rates, is somewhat under a cloud; (3) that the case has never yet been proved that joint electricity supply schemes would be of a more profitable character than the development of the existing stations, with probably amalgamation of the larger stations with the smaller and less economical ones; and (4) the schemes are destined (or rather that was the idea) to supply industries run by private enterprise, and those who carry on such industries have come to the conclusion that private enterprise can be electrically served quite well by private enterprise without danger to the rates.

Divided Opinion.

Considerations.

At the inquiry into the Aire and Calder schemes for the West Riding district (which has forced upon the consideration of the Electricity Commissioners projects from Leeds, a conference of local authorities captained by Bradford, and the Yorkshire Power Company), the South Yorkshire Coal Trade Association told the Commissioners flatly they had no confidence

in the skill and power of the municipalities to make these schemes pay. The Association stated that they pay one-third of the rates in the districts in which they operate; and they have many instances of the reckless way in which public authorities proceed. There were also submissions that schemes can be too large for economy and efficiency. This is quite true, as is proved by the fact that there are private generating plants to-day on a relatively small scale that can supply their manufacturing owners at a cost below that at which a larger station can supply with its distribution expenses and losses, and other expenses due to the nature of its business. The Yorkshire Electric Power Company stood well in the inquiry in respect of the amount of support that it obtained. The local authorities are now looking upon the Company in a new light. The Company is a power to be reckoned with. And it has no intention of being snuffed-out of existence without it has complete recompense; and, so far as can be seen, there is no desire on its part for this to happen. We see at Elland the Company are now supplying the Council with energy; and the old local generating plant is soon to be dispensed with. The undertaking has never paid; but it is hoped that, under the new order of things, a profit will result from the trading. However, the weight of evidence at the inquiry, was distinctly in favour of private ownership. The "Electrician" says: "Some of the witnesses seem to have been obsessed by the bare possibility of a call upon the rates; but, as we have frequently pointed out, this is a remote contingency in any well-devised scheme." "As we have frequently pointed out," such statements can be branded as mere postulation. There is no such proved margin of advantage in joint administration over private enterprise that the risks attaching to the former need be encountered. The abandoned Lower Severn scheme is eloquent of indeterminate opinion as to the value of joint generating and distribution schemes run by authorities of hybrid constitution.

The Bill and Two Voices.

"Electrical Industries" is not optimistic regarding the joint authorities. It sees very little chance of these authorities coming into existence as trading bodies; and, in short, it appears to it that it will be better to rule-out the whole of the projects. This is what, in its opinion, will anyway finally happen, after a long and disastrous delay, during the whole of which there will be nothing but stagnation in electricity supply. The passing of the Electricity (No. 2) Bill, we understand, would in its view mean continued sterility for both the supply industry and the manufacturing industry, and would, indeed, constitute by its very existence a menace which would hamper development in the future. The only solution is for the House of Commons to dismiss summarily the Bill once and for all, and so signify its approval of the existing undertakers going forward on business lines, to the good of all concerned. On the other hand, in an article replying ineffectually to the criticisms of a contributor in its own columns, to which criticisms reference was made in the "Memoranda" last week, the "Electrical Review" holds that the fundamental aim of the reorganization of the industry is the provision of an abundant and cheap supply of electricity. It admits that this is a question which can only be decided by a detailed study of the conditions obtaining in each case, which is one of the main objects of the inquiries that are being held by the Electricity Commissioners. We think the main object of the inquiries by the Commissioners is to get what in their wisdom is the best scheme of consolidated generation that is put before them. But whether the result will be an abundant and cheap supply of electricity is a matter that is purely hypothetical. The championship of the "Electrical Review" is altogether destitute of certainty. Vagueness predominates. It was glad indeed to find that its critic confined himself to the Metropolitan area; but the fact remains that, if so much criticism of joint authority enterprise in electricity generation can be directed to the Metropolitan area, the arguments apply equally well to areas of less importance, and of less density. As a matter of fact, the exposure by the critic of the relaxation there has been in respect of finance, and the making of the joint authorities self-supporting, is something of general application. Our contemporary, however, argues that the Bill is necessary to electricity supply reform in London; and so we may take it that, in its considered opinion, it is necessary elsewhere. Men of great commercial acumen take the contrary view. The fact of the matter is this question has been badly handled from the first. The Government went sailing gaily along on behalf of electricity. A lot of silly things were said regarding what electricity could do for the country; and now that men of financial and commercial capacity have given the proposals their consideration, the facts of the situation compel them to disagree. Are the Government to-day showing the same enthusiasm for the reorganization of electricity supply? If not, why not? Something must have happened to put a spoke into this particular wheel.

Coke and Breeze for Steam-Raising.

One thing may be that the Government have learned more than the Departmental Electric Power Committees chose to tell them as to the fact that "the most valuable property of the nation" (as the Premier recently described it) has something more in it than fuel value. Also that from the point of view of fuel, the generation of electricity is not the most economical use that can be made of raw coal; that coal contains commodities of vast importance to the community; and that industry requires heat in greater abundance than power. Sir Arthur Duckham has consistently urged that a mistake was made in appointing Committees to consider electrical power only; and that it should have been referred to a Committee to consider the related questions of fuel and power in all their bearings. Had this been done, how different things might have been; and there would then, we could have hoped, have been some real constructive work done. In the address of the President of the Institution of Gas Engineers (Mr. Thomas Goulden, M.Inst.C.E.), which we published last week, there is reference to the considerable advance that is being made in the use of coke for industrial purposes; and it is pointed-out that there are great possibilities in the direction of coal conservation by the use of inexpensive breeze and small coke for the production of steam at electricity generating stations. Our electrical friends might mark his words: "It is a matter for serious consideration whether the whole question of coal conservation, so far as the future of electricity generation is concerned, should not be re-opened with a view to ascertaining whether the economical production of both gas and electricity cannot better be secured by combination and co-operation rather than by continuing on the divergent lines hitherto followed." If there was an inquiry to-day, the gas industry could call several electrical engineers to give evidence as to the efficiencies and money savings they have secured by the use of the patent "Sandwich" system of blending coal and coke or breeze for steam-raising. Every pound of coke or breeze used in this way means raw coal saved.

Internal Combustion Engines.

Talking of fuel, the miners' strike has shown the electrical industry the folly of "placing their eggs all in one basket" by using only coal for steam generation. The strike has proved to professional men that oil and coke are remarkably good fuels, and have in some respects advantages superior to coal. Mr. S. H. Fowles, of Jarrow-on-Tyne, also takes the industry to task for having gone on so long without utilizing to a greater extent gas and Diesel engines—the latter of which at any rate have been running in several stations for upwards of ten years. With both types of engine, Mr. Fowles has spent many happy years. He asks what might have been the case if 20 or 30 p.ct. of the plant of our medium and small electric stations had been Diesel or gas engines working on a new type of producer, in which coke can be used efficiently, and the tar burnt-off at the furnace top. Most Diesel engine makers, he says, guarantee to produce 1 KW.-hour for 0·5 lb. of crude oil. Taking a case of coal costing £3 per ton, and a consumption of 3·42 lbs. per KW.-hour generated, the fuel cost is 1·097d. per KW.-hour. If oil is as high as £7 per ton, at 0·5 lb. per KW.-hour generated, the cost works out at 0·375d. per KW.-hour, or just about one-third the cost. In the case of the smaller stations where the coal used per KW.-hour is much more, the comparison would be considerably worse for coal. Mr. Fowles is of opinion that many extensions to-day to the medium and the smaller stations should be in the field of gas and Diesel engines. "Where any gas is available, it should certainly be used at its maximum efficiency, and then the case of the Diesel engine should be very carefully considered for any extensions to run in parallel with the existing plant."

Small House Custom.

Owing to the great cost involved, the Housing Committee of the London County Council have decided not to instal both gas and electricity in the houses in the Ilford No. 1 housing section, known as the Becontree scheme. Therefore the least economical agent for all purposes has got to go; and the terms of the Gas Light and Coke Company have been accepted. The contract applies to some 2800 houses. Gaslight is to be adopted; and in every house there will be a gas water-heater, a built-in gas-fire in one of the bedrooms, and gas will be used for cooking. Gas cannot be dispensed with in this class of property; and it is therefore a pity to incur tremendous capital expenditure in putting-in electricity for the small purpose of lighting only. For the revenue that would be obtained, the capital expenditure would not be justified. We see that at Bedford a new form of tariff has been adopted for electric lighting in small houses. Consumers who require not more than five 20-watt lamps may now adopt this method. At the beginning of each quarter, the householder will be required to declare the number of 20-watt lamps (not exceeding five) that will be alight at any one time, and to pay in advance the 4s. per quarter per 20-watt lamp. If the amount so assessed be not paid within fourteen days after the usual quarter days, the supply will be cut-off without further notice. How is a householder to tell at the beginning of a quarter how many lamps he will require to be alight at any one time during the quarter? And after the declaration is made at the beginning of the quarter, what check will there be that the declared number of lamps is never exceeded? Perhaps, however, the people of Bedford are universally honest.

The 32nd congress and health exhibition of the Royal Sanitary Institute is to be held at Folkestone from the 20th to the 25th inst., under the presidency of the Earl of Radnor. The programme indicates a busy and useful week for the large number of delegates who will be attending; and various attractive excursions, &c., have been arranged. The congress will open with a reception by the Mayor of Folkestone.

STEAMING IN VERTICAL GAS-RETORTS.

By Sir GEORGE BEILBY, F.R.S., Director of Fuel Research of the Department of Scientific and Industrial Research.

[A Paper prepared for the Annual Meeting of the Institution of Gas Engineers.]

[*Concluded from p.* 548.]

GRAPHIC REPRESENTATION OF RESULTS.

In addition to the complete tables, wherein are set out all the results of the various tests, a method of graphic representation has been adopted, which has been prepared with a view to enabling anyone concerned to estimate at once up to what point it would be economical to "steam the retorts" in his own particular case.

The graphs have been drawn-up so as to show the cost in steam supplied to the retorts and in heat supplied to the combustion chambers which must be paid for the additional therms obtained in the form of gas, and the additional gallons of tar and pounds of sulphate of ammonia produced, with the corresponding variations in calorific value and volume. The reduction in the quantity of coke produced and the increase in the quantity of breeze are also shown. It has been considered essential to state the heat supplied to the settings and the retorts in terms of therms of gas and therms of steam, because of the varying nature of the supply and cost of these sources of heat.

The quantity of producer gas made per cwt. of coke, its calorific value, and its cost vary in every case according to the system used and the condition of the producers. The cost of steam also varies according as to whether it is generated by making use of waste heat or whether it has to be specially produced in boilers for the purpose. It is believed, however, that in each particular case the gas engineer will be able to calculate the cost per therm of the gas and steam supplied to the settings and retorts. He will also know exactly the value of the increased yields of gas, tar, and sulphate, and the loss which will accrue owing to the decrease in the total yield of coke, with the increase in the proportion of breeze.

"Heat Equivalent" of the Setting at the Fuel Research Station.—In preparing and using the graph so that it may be applicable to all settings, it is essential that the "heat equivalent" of the particular setting in question should be eliminated. The heat required to maintain at carbonizing temperature the settings of vertical retorts at the Fuel Research Station with no coal passing through the retorts was determined by special tests carried out as described in Appendix II. This quantity has been called the "heat equivalent" of the setting, and amounts to 12·4 therms per hour at 1260° C.

In these tests the setting is debited with the whole of the potential therms supplied in the fuel gas. The whole of this heat is dissipated by radiation and convection from the setting, and as sensible heat in the flue gases.

Preparation of Graphic Representation.—As examples of how the figures which are graphically represented were obtained, the cases of Tests "D" and "E" are set out below.

In Test "D," in which no steam was supplied, the total heat supplied to the setting per hour amounted to 19·11 therms. From this must be subtracted the "heat equivalent" of the setting, 12·4 therms per hour, leaving only 6·7 therms per hour to be expended in the process to bring about the carbonization of 0·42 ton of coal in the retorts.

From this it will be seen that the heat expended in the process in order to bring about the carbonization of one ton of this coal without steam amounted to 15·9 therms. It is considered that this figure of 15·9 therms per ton of Mitchell Main gas nuts (without steam) will be approximately the same for all Glover-West settings worked at the same temperature (1260° C.).

The coal gas obtained is measured in therms per ton of coal carbonized. The coke produced is measured in cwt. per ton of coal carbonized, the tar in gallons, and the sulphate of ammonia in lbs. per ton of coal carbonized. The calorific value and volume of the gas are also shown.

In test "E," 5 p.ct. of steam was added to the retorts. This amounts to 0·54 therm per hour. The heat supplied to the combustion chambers of the setting amounted to 16·8 therms, making a total heat supplied to the setting and retorts of 17·3 therms per hour. Of this, 12·4 therms is the heat equivalent of the setting, and must be eliminated. Therefore 4·9 therms were supplied to the setting and the retorts in order to work the process, and so bring about the carbonization of 0·414 ton of coal in the retort. This represents 11·9 therms per ton as the total heat expended in order to work the process, and so bring about the carbonization of one ton of Mitchell Main gas nuts in the retorts when using 5 p.ct. of steam.

These results have been incorporated in figs. II., III., and IV. A full explanation of the construction of these will be found appended to the figures.

GENERAL OBSERVATIONS ON TESTS.

In the course of some general observations on the tests, the report states that, owing to the low percentage of moisture in the English coals carbonized, the results have been expressed directly in terms of coal as charged. The ash was in all cases rather high. The coals proved quite satisfactory for vertical work with moderate steaming. The Durham and Lanarkshire coals are less responsive to the action of steam, however, and would apparently stand more steam than the South Yorkshire coal.

Though these coals were also carbonized without steam, it was apparent that such a procedure was quite unsuitable for vertical retorts with the arrangement of chambers as fitted at the Research Station, owing to the heat developed in the lower castings. As a result of our experience, it is considered that these retorts ought never to be worked entirely without steam, but that a minimum of 3 to 5 p.ct. should always be used.

The yields of gas, tar, and ammonium sulphate increased with increased steaming, while the coke decreased. These changes have been expressed graphically as well as in tables.

When examining figs. II., III., and IV., it must be borne in mind that the temperatures of carbonization are lower in fig. IV. than in the others, and that they varied in each test.

From a comparison of these figures, it will be seen that the South Yorkshire coal is easily the best for gas-making purposes, both as regards yield of gas per ton of coal and as regards the heat required for carbonization. The Lanarkshire coal gives much better yields of tar and sulphate of ammonia; while the Durham coal gives the most coke.

It is apparent that the benefit to be gained by steaming the Durham coal is relatively small compared with the gain from the South Yorkshire coal treated in the same way. The same might be said of the Lanarkshire coal, were it not for the very high yields of tar and sulphate of ammonia.

Flue Gases.—The results of analyses of flue gases are shown in Table 7, where it is seen that the proportion of excess air was kept approximately the same in each test.

Coke.—The percentage of volatile matter in the coke was very low, and was not affected by increased steaming. This would indicate that, at a normal throughput, the reduction of volatile matter in coke depends solely on the temperature of carbonization. The effect of steaming on the coke was to reduce the size of the pieces more than is indicated in the increase in actual breeze, while the friability was distinctly increased.

Liquor and Ammonium Sulphate.—In all the tests the yields of ammonium sulphate given are theoretical quantities of the pure salt present in the liquor collected. In making use of this figure in the graphs, the amount escaping in the gas has been added, as in some tests the quantity was considerable, and if not included would have affected the regularity of the results.

The low yields may be attributed partly to the low nitrogen in the coals and partly to the high ascension-pipe temperatures which obtained with high steaming of such dry coals. On one occasion the actual ammonia content of the vapour leaving the ascension-pipe was determined and found to be very little higher than the yield calculated in the usual way.

Retorts and Settings.—The retorts and settings were examined by Mr. Hislop, of Uddingston, on March 29, 1921, when they had been in use for 358 days. Steam had been supplied to the retorts continuously, except for very short periods, and had most of the time considerably exceeded 15 p.ct. of the coal throughput. Mr. Hislop reported that the retorts were in excellent condition, and showed no signs of erosion or wear due to steaming.

THERMAL EFFICIENCY OF CARBONIZATION.

In order to compare the efficiency of carbonization in each of the tests carried out, the temperatures of the flue gases leaving the preheater have been noted, and the loss of heat from this cause calculated. This loss, in conjunction with that from the preheater itself and the assumed constant value for radiation, &c., from the setting [Appendix II.], when deducted from the heat supplied to the retorts, gives a value for the net amount of heat required to carbonize the coal and remove the products at the working temperatures. The results obtained are set out for comparison in Table 9, where the losses from each source are also shown.

In the case of Mitchell Main coal, the net amount of heat required per ton of coal is 7·53 therms with 5 p.ct. steam, and 9·62 therms with no steam, showing that less heat is required as the percentage of steam is increased, up to a figure which appears to be less than 5 p.ct. Above this figure the amount of heat required rises again, and increases with increased steaming.

It must be remembered that the sensible heat carried off in the gas, coke, &c., alters with each set of conditions, decreasing in the case of coke and increasing in the case of the volatile products with increased steaming.* There is, however, apparently a value in the region of 3 p.ct. of steam which gives the most efficient results with all the coals used. This fact is most clearly shown in the graphs for Mitchell Main coal. (Fig. III.)

The point at which, in the case of Mitchell Main coal, the addition of steam to the retorts ceases to be economical from thermal considerations, is shown in fig. VIII. of Appendix IV. Here the

* This heat absorption causes a fall of the temperature of the exposed metal portions at the lower end of the retort, thus reducing the radiation losses.

FIG. II

CARBONISATION OF DURHAM COAL (CONSETT) WITH COMBUSTION CHAMBERS AT 1260°C. USING VARYING PERCENTAGES OF STEAM.
GRAPHS SHOW HEAT SUPPLIED IN THE FORM OF BLUE WATER GAS & STEAM, & ALSO YIELDS OBTAINED AT FUEL RESEARCH STATION.

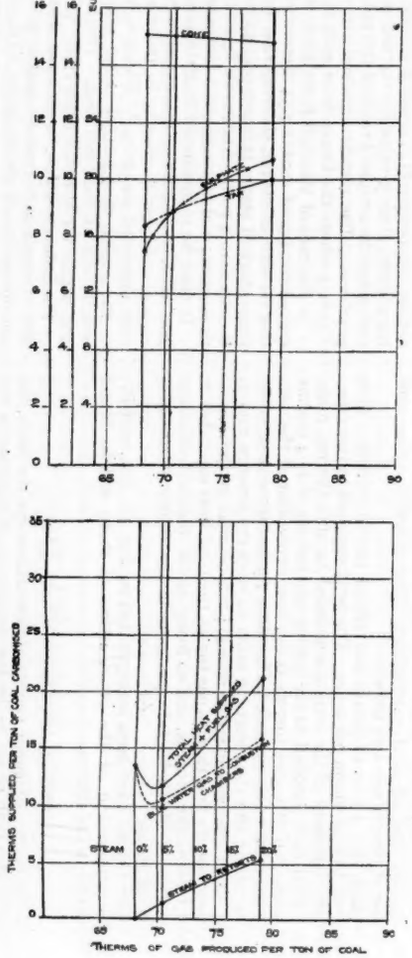

COKE
SULPHATE
TAR
THERMS SUPPLIED PER TON OF COAL CARBONISED
TOTAL HEAT SUPPLIED STEAM + FUEL GAS
BLUE WATER GAS TO COMBUSTION CHAMBERS
STEAM 0% 5% 10% 15% 20%
STEAM TO RETORTS
THERMS OF GAS PRODUCED PER TON OF COAL

FIG. III

CARBONISATION OF SOUTH YORKSHIRE COAL (MITCHELL MAIN GAS NUTS) WITH COMBUSTION CHAMBERS AT 1260°C. USING VARYING PERCENTAGES OF STEAM.
GRAPHS SHOW HEAT SUPPLIED IN THE FORM OF BLUE WATER GAS AND STEAM, AND ALSO YIELDS OBTAINED AT FUEL RESEARCH STATION

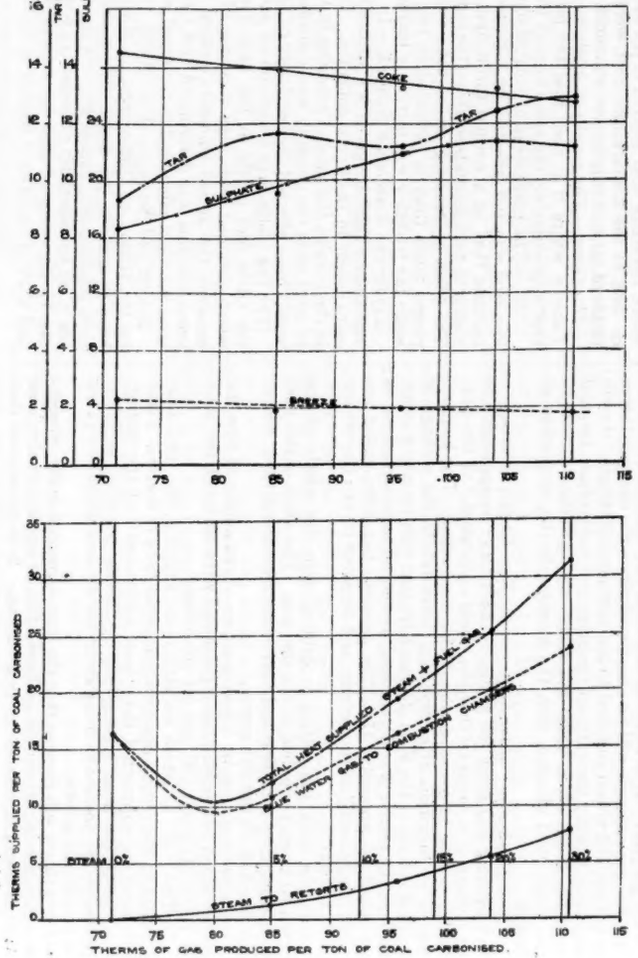
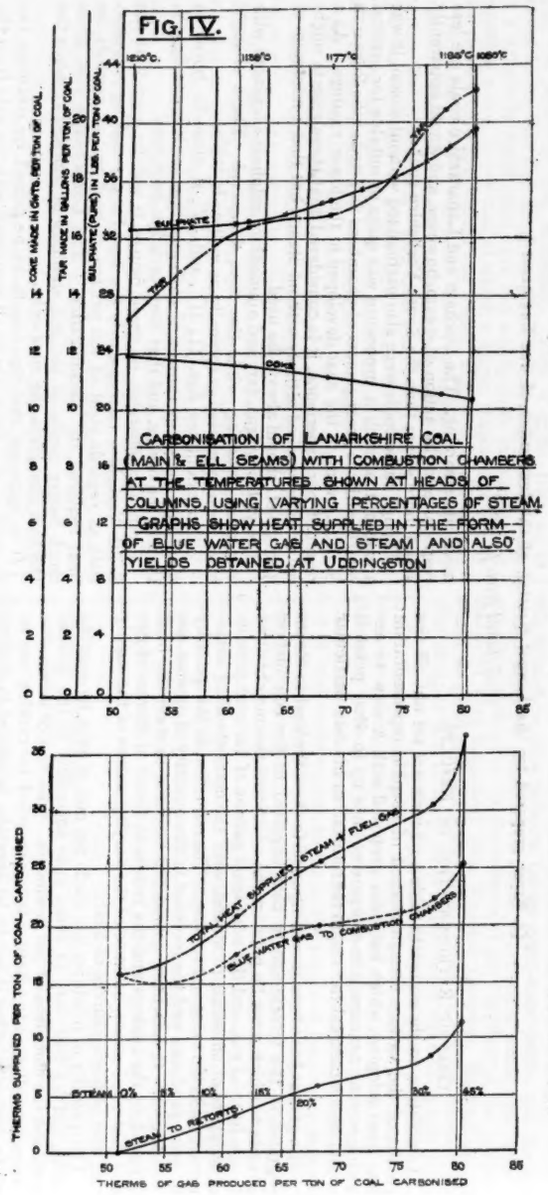
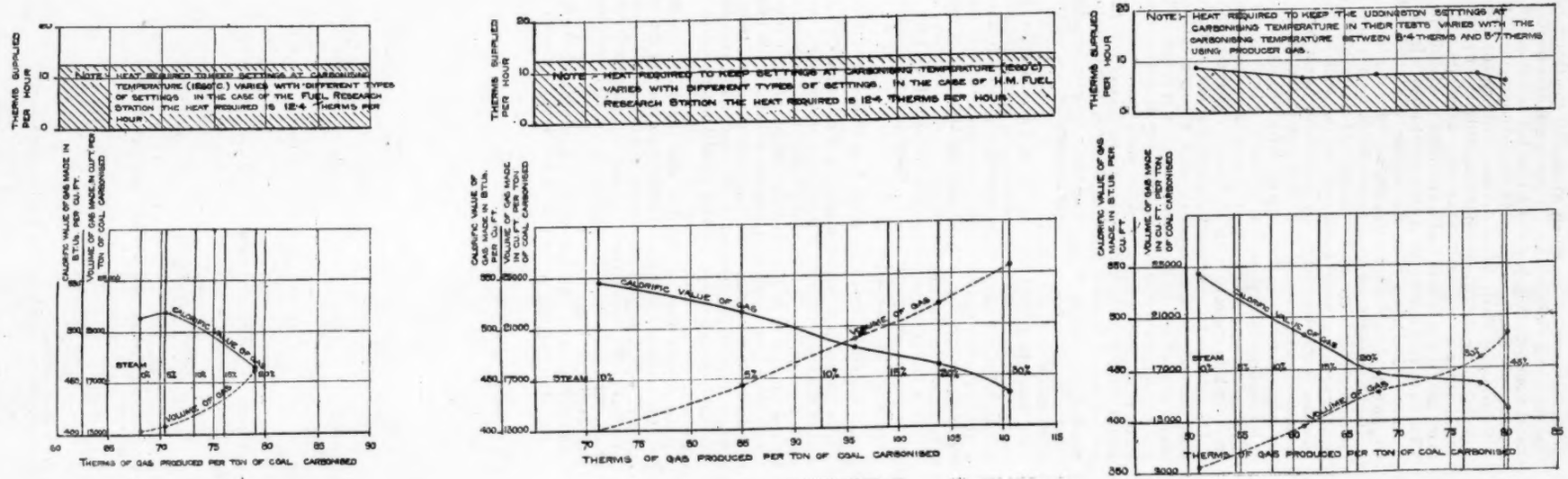

COKE
TAR
SULPHATE
THERMS SUPPLIED PER TON OF COAL CARBONISED
TOTAL HEAT SUPPLIED STEAM + FUEL GAS
BLUE WATER GAS TO COMBUSTION CHAMBERS
STEAM 0% 5% 10% 15% 20% 30%
STEAM TO RETORTS
THERMS OF GAS PRODUCED PER TON OF COAL CARBONISED.

FIG. IV.

CARBONISATION OF LANARKSHIRE COAL (MAIN & ELL SEAMS) WITH COMBUSTION CHAMBERS AT THE TEMPERATURES SHOWN AT HEADS OF COLUMNS, USING VARYING PERCENTAGES OF STEAM. GRAPHS SHOW HEAT SUPPLIED IN THE FORM OF BLUE WATER GAS AND STEAM AND ALSO YIELDS OBTAINED AT UDDINGSTON




THERMS SUPPLIED PER HOUR
NOTE:- HEAT REQUIRED TO KEEP SETTINGS AT CARBONISING TEMPERATURE (1550°C.) VARIES WITH DIFFERENT TYPES OF SETTINGS. IN THE CASE OF THE FUEL RESEARCH STATION THE HEAT REQUIRED IS 12·4 THERMS PER HOUR.
NOTE:- HEAT REQUIRED TO KEEP SETTINGS AT CARBONISING TEMPERATURE (1550°C.) VARIED WITH DIFFERENT TYPES OF SETTINGS. IN THE CASE OF H.M. FUEL RESEARCH STATION THE HEAT REQUIRED IS 12·4 THERMS PER HOUR.
NOTE:- HEAT REQUIRED TO KEEP THE UDDINGSTON SETTINGS AT CARBONISING TEMPERATURE IN THEIR TESTS VARIED WITH THE CARBONISING TEMPERATURE BETWEEN 9·4 THERMS AND 9·7 THERMS USING PRODUCER GAS.
CALORIFIC VALUE OF GAS MADE IN B.T.Us. PER CU. FT.
VOLUME OF GAS MADE IN CU. FT. PER TON OF COAL CARBONISED
CALORIFIC VALUE OF GAS
VOLUME OF GAS
STEAM
0%
5%
10%
15%
20%
30%
THERMS OF GAS PRODUCED PER TON OF COAL CARBONISED

EXPLANATION OF GRAPHS.

In all the graphs the abscissæ are in therms of gas produced per ton of coal carbonised. In the centre graph in each of FIGS. II, III *and* IV, *the ordinates are in terms of therms supplied per ton of coal carbonised. In this graph will be seen the steam expended (plain), the fuel gas expended (dotted), the total heat expended being the addition of the two (chain). In the lower graph the ordinates are in terms of therms supplied per hour. This graph (hatched) represents the heat equivalent of the setting, and is a constant throughout. It does not vary with the throughput of coal, and therefore cannot be represented in terms of therms per ton of coal carbonised. Below this again are the graphs showing the calorific values (plain) and volumes (dotted), corresponding to the therms of gas produced. The upper set of graphs refer to the coke, breeze, tar and sulphate of ammonia produced. The ordinates referring to coke and breeze are cwts. per ton. The breeze is represented by a dotted line, the total coke by a plain line and the "saleable coke" is the difference between the two. The ordinates with reference to the tar (chain) are in terms of gallons per ton of coal carbonised. The ordinates with reference to sulphate of ammonia, star chain, are in terms of lbs per ton of coal carbonised. Vertical lines have been drawn through the graphs at points representing 5, 10, 15, 20, and 30 % of steam. By substituting the "heat equivalent" of any particular setting for that shown in the graph, which refers to the retorts at the Fuel Research Station, the heat required in any case is easily found.*

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abscissæ are in terms of therms of gas produced additional to those produced when carbonizing without the use of steam. The ordinates measure the heat value in therms of the steam (plain), fuel gas (dotted), coke consumed in the retorts (chain), which are expended in the setting in order to produce the additional gas; while the thermal value of the tar produced at the same time is subtracted from the total gross value (chain), and gives us the total net value (star chain) of the thermal cost of producing the additional coal gas.

It will be noted that this crosses the economy line (45°) at an additional production of 23 therms when the steam expenditure is about 11 p.ct. By a coincidence, with this particular coal this point closely approximates to that up to which steaming can be resorted to without requiring extra heat from the fuel gas beyond that required for dry carbonization.

The question of thermal economy is very greatly affected by the consumption of coke inside the retorts and the yield of tar obtained from the coal. This is demonstrated by the fact that the thermal economic limit of steaming the Lanarkshire coal at the reduced temperatures used at Uddingston is not reached apparently till 45 p.ct. of steam is used with an additional production of 29·5 therms of gas. In this case the result is evidently due to the large yields of tar.

With the Durham coal, tests have not been carried far enough to indicate the limit; and the main cause of this is evidently the small consumption of coke inside the retorts.

It is interesting to note that the heat made use of in carbonizing the Mitchell Main coal and removing the products at working temperature is 3·14 p.ct. of the heat units in this coal.

Thermal Efficiency of the Research Station Setting and a Standard Glover-West Setting.—In considering the thermal efficiency in the station setting, we must first discuss the effect of the special air preheater, as this is not usually installed in a Glover-West retort.

The action of this preheater is distinctly shown in the special test for determination of heat losses from the setting which is detailed in Appendix II., and was carried out with no coal passing through the retorts. It may be summarized as follows:

	Per Cent.
Heat dissipated through radiation, convection, and conduction from retort-setting	66·7
Heat dissipated through radiation, convection, and conduction from the preheater	8·5
Total losses through radiation, convection, and conduction	75·2
Heat carried off in flue gases	24·8
	100·00

It will be seen from Appendix II. that, by means of the preheater, 12·4 p.ct. of the heat used was returned to the retort-setting.

If the preheater had not been in use, the heat dissipated through

radiation, &c., in the retort-setting would have been approximately the same; but the quantity of gas required to maintain the same temperature would have been increased, and therefore the proportion of losses would have been approximately as follows:

	Per Cent.
Heat dissipated through radiation, convection, and conduction from the retort-settings	59·25
Heat carried off in flue gases	40·75
	100·00

When carbonizing, these losses, of course, form a smaller proportion of the total heat supplied to the setting; but even so they are such as to make the thermal efficiency of the setting in its present form very low. The figures for the two limits with Mitchell Main coal are as follows:

	No Steam. Per Cent.	30 P.Ct. Steam. Per Cent.
Heat dissipated through radiation, convection, and conduction from retort-setting	43·5	32·7
Heat dissipated through radiation, convection, and conduction from the preheater	6·5	5·7
Total losses through radiation, convection, and conduction	50·0	38·4
Heat carried off in flue gases	28·9	25·9
Total losses	78·9	64·3
Heat made use of in carbonizing coal and removing products at working temperature	21·1	35·7
	100·0	100·0
	Per Cent.	
Thermal efficiency of setting with superimposed preheater	21	36

If the preheater had not been in use, the comparative values of the respective losses would have altered; the loss from radiation, &c., becoming a smaller proportion of the whole and the flue gas loss a greater proportion, as follows:

	No Steam. Per Cent.	30 P.Ct. Steam. Per Cent.
Heat dissipated through radiation, convection and conduction from retort-settings	40·0	30·0
Heat carried off in flue gases	40·7	37·2
Total losses	80·7	67·2
Heat made use of in carbonizing coal and removing products at working temperature	19·3	32·8
	100·0	100·0
	Per Cent.	Per Cent.
Thermal efficiency of setting without superimposed preheater	19	33

Presumably this (with due allowance for the use of producer gas instead of water gas—see Appendix III.) would be approximately the efficiency of any standard setting isolated the same way; but when the setting is one of a bench, the radiation, convection, and conduction losses would certainly be less, and therefore the thermal efficiency would be greater.

By making use of the figures obtained in tests "J" and "K," for the heat expended in carbonizing the coal and removing the products at working temperature—viz., 11·5 and 17·25 therms per ton—and for the total heat supplied to the Uddingston settings in Tests 1 and 3, it appears that the efficiency of the Uddingston settings is 41·8 and 61 p.ct., compared with 34 and 56·4 p.ct. in the Research Station settings at the same temperature with 0 and 22 p.ct. of steam in use respectively.

In the case of the Uddingston settings it is impossible, without further information, accurately to allocate the loss between the flue gases and radiation, &c. It seems doubtful, however, if the losses from radiation, &c., would ever fall as low as either 10 or 7·5 p.ct.—the figures suggested in the Uddingston report.

Behaviour of Steam in the Retorts.—With regard to the steam supplied to the retorts, the amount actually lost by leakage and condensation is very small in any test. In certain of the preliminary tests it was evident that a 5 p.ct. loss could easily be attained with what appeared to be a very slight leakage from the coke-chamber. In further tests this leakage was prevented almost completely by carefully packing the coke-chamber doors.

The loss of steam by condensation in the coke is negligible, as the coolest part of the coke is always well over 200° C., and the small amount of water condensed on the walls of the coke-chamber is not absorbed to any appreciable extent by the coke. A special test indicated that the moisture in the wettest part of the coke was not more than 0·2 p.ct. above the average (0·15 p.ct.). It is considered, therefore, that the loss of steam by condensation in the coke-chamber is not such as to make the use of superheated steam or high-pressure steam necessary or even desirable.

The total quantity of steam decomposed has been calculated from the analyses of the coal gas, and is shown in Table 10, together with what may be referred to as excess gas. The composition of this excess gas shows definitely that the action of the steam is not merely that of making water gas. It may be presumed that the steam forms water gas on contact with the incandescent coke. It seems probable that this highly heated water gas, in its passage up the retort, assists in the carbonization of the charge, though at a slightly lower temperature and with a change in the composition of the coal gas.

An increased yield of gas from the coal is obtained without the necessity for any additional heat from the combustion chambers. In fact, it is necessary actually to reduce the external heat applied until the quantity of steam added becomes more than the incandescent coke can deal with without the assistance of extra heat from the combustion chambers.

[From the tables accompanying the report we have omitted Table 3, Coal Analyses; Table 5, Coke Analyses; and Table 6, Analyses of Tar and Liquor.]

Economic and Practical Limits of Steaming.

It is hoped that, by totalling-up the gains on the one hand against the losses and cost of production on the other, as affected by local prices, figs. II., III., and IV. will enable anyone considering the question to decide when the economic limit of steaming in his particular case has been reached with the coals here mentioned; but quite apart from the economic limit, there is the ultimate limit of conductivity of the retort walls, and there are practical limits also beyond which special arrangements will be necessary.

It has already been noticed that, with the same heat supplied from the producers to the combustion chambers for the carbonization of a given throughput of coal in a dry state, it is possible to carbonize the same quantity of coal using a quantity of steam which varies with the coal, resulting in a considerably increased yield in therms of gas.

In the case of the Durham coal this possible quantity of steam amounted to 15 p.ct.; in the case of the South Yorkshire coal to

Table 4.—*Results of Laboratory Low-Temperature Distillations at* 600° *C.*

Coal.	Grms. per 100 grms. Coal.						Gas at 60° Fahr. and 30 in. Saturated.	
	Coke.	Oils.	Liquor.	NH_3.	Gas.	Total.	Cc. per 100 Grms.	S.G. (Air = 1).
(1) Consett	80·75	9·90	2·00	0·006	7·15	99·81	9,550	0·620
(2) Mitchell Main gas nuts	75·55	13·30	2·75	0·010	8·30	99·81	10,690	0·645
(3) Lanarkshire Main and Ell	71·65	12·80	6·50	0·120	8·89	99·96	11,305	0·646

	Behaviour on Distillation.	Appearance of Coke.
(1)	Oil vapours first appear at 380° C. Gas starts slowly at 400° C. Gas becomes rapid at 420° C. Brown fumes continue from 480° to 540° C. Oils very light in colour.	Bright black surface. Structure very porous and swollen, but particles well fused together.
(2)	Oil vapour first appears at 340° C., and drops of oil at 350° C. Gas starts slowly at 350° C. Rapid evolution of gas commences about 400° C.	Bright black surface. Structure very porous and swollen, but less than Consett.
(3)	Oil vapours first appear at 370° C. Gas starts slowly at 390° C. Gas becomes rapid at 420° C.	Dull black, with no swelling. Particles cohered, but structure fairly easily broken down.

12·5 p.ct.; and in the case of the Lanarkshire coal, it presumably amounts to about 10 p.ct. If it is desired to steam beyond this point, then the question arises as to whether the producers can provide sufficient gas for the purpose, taking due account of the character of the coke discharged from the retorts.

It will be noted, for example, on referring to fig. III., that in the case of the South Yorkshire coal, by an addition of 7·7 therms to the gas supplied to the combustion chambers in the case of 12½ p.ct. steaming, a further 17½ p.ct. of steam can be used with an increased yield of 15 therms of gas and with a corresponding increase of tar and ammonium sulphate.

Another factor which may limit the quantity of steam with some strongly caking coals is the sticking of the charge in the retorts. There appears to be a great increase in the tendency to stick, as the quantity of steam is increased beyond a moderate amount. In the case of the South Yorkshire coal, the tendency to stick during the 30 p.ct. test became so acute that constant labour and attention were required to keep the charge travelling through the retorts.

It is understood that this difficulty may be overcome to a great extent by extracting, and therefore charging the retorts intermittently; but no trial of this method has yet been made at the Fuel Research Station.

This particular coal was also troublesome when carbonizing dry; but on the other hand sticking occurred only occasionally when 5 p.ct. and 12½ p.ct. of steam were in use. The other coals treated seemed to be little if at all affected in this direction by steaming in any quantity reached during the experiments.

The problem of circulation through the collecting main also becomes somewhat acute when steaming heavily with either of the first two coals. When using Durham coal, there were many occasions when the heavy tar in the collecting main frothed-up and boiled over, so causing the blocking of ascension-pipes, and in some cases the overflow of the main seal-pot close to the retort-house governor. With the South Yorkshire coal, the difficulty does not seem to go beyond a considerable thickening of the tar in circulation. These difficulties do not appear to be insuperable, however, where it is permissible to effect a daily change in the circulating medium, as can be done at any works where exact measurement is not essential.

The experiences mentioned above apply to a case where the maximum throughput of coal through the retorts was maintained. If the throughput was reduced so that the output in therms of gas per retort were not appreciably increased, a new set of conditions would be introduced where the difficulties in question would probably no longer appear.

Suggestions for Consideration on Practical Points.

The heat losses in vertical settings are very greatly influenced by the temperature of carbonization and by the design of the combustion chambers in the setting. As stated before, the heat losses in an isolated vertical setting of four retorts in which the combustion chambers encircle each pair of retorts and are kept at 1260° C. amount to about 80 p.ct. of the heat supplied when working without steam and 67 p.ct. when 30 p.ct. of steam is added. This means that of the value of the coke consumed in the producers and boilers for a throughput of 10 tons of coal per day, there would be a daily waste of about £5 in the first case, and of £6 10s. in the second, taking the value of coke at 37s. 6d. per ton.

With lower working temperatures, 1210° C. and 1180° C. without steam and with 22 p.ct., these losses would amount to 66 p.ct. and 52 p.ct. of the total heat supplied, equal to a daily waste of £3 15s. and £4 2s. on a throughput of 13 tons per day.

In the Uddingston setting, where the combustion chambers are straight and are maintained at 1210° C. or less, the losses apparently amount to 58 p.ct. of the heat supplied when working without steam, and 39 p.ct. when 22 p.ct. of steam is added. This works out at a waste of £3 and £5 in the two cases on a throughput of 25 tons per day. When the extent of this waste is realized, it is felt that gas undertakings should do all in their power to encourage the manufacturers of vertical retorts to produce a more thermally efficient installation.

Such a plant can hardly be hoped for without an increase in first cost; but even on the smallest settings a saving of (say) half the present waste would soon repay this increase. The loss through radiation, convection, and conduction appears to be reduced to a minimum, as far as arrangement is concerned in those settings with straight-through combustion chambers; the fuel gas and air entering at one end, and the flue gases leaving at the other.

It would seem that lagging in some form must be resorted to for further improvement. Heavier brickwork as at present fitted to the ends of benches would appear to be the simplest form, and would have considerable effect. The ratio of the radiation from the end and side walls of the Research Station setting is apparently about as 1 to 3.

The disadvantages with regard to access to the flue damper are, of course, obvious; and the extra weight would require heavier foundations. But these would be more than counteracted if a 50 p.ct. reduction in radiation were obtained. It is understood that 1 ft. of sand placed on the top of the setting has been tried, with beneficial results both with regard to the comfort of the retort stokers and to the prevention of leakage at the top of the retorts.

The losses through all the cast-iron fittings and steelwork in the walls of the retorts, damper access doors, sight holes, &c., are manifestly very considerable. It is therefore evident that these fittings should be reduced to a minimum. It would seem that brick sight-holes and plugs could be substituted for the cast-iron sight-boxes in most cases; the size of the hole through the brickwork being reduced to a minimum. It also seems possible to insert some form of brick plug in the passage within the damper access doors—particularly would this be so if the brickwork were increased in thickness.

The heat in the flue gases could probably be applied most efficiently from the thermal point of view to the raising of steam; but it is felt that no gas engineer could face with equanimity the prospect of the addition of a whole battery of boilers to his already complicated plant.

The cost of cleaning and upkeep alone would form a considerable item, in addition to the probably increased wages bill for attendance. The question of efficient supervision would certainly arise, though anxiety on this score might be considerably alleviated by the introduction of really sound automatic feed regulating apparatus for the boilers, of which there are several on the market, usually fitted to marine water-tube boilers. The collection of the flue gases from a bench of retorts, to pass through one or possibly two large-sized boilers, would be more acceptable from the works point of view; but the initial cost for construction would be very heavy whether the boiler were placed on the top of the settings or on the ground level with suitable flues and chimney.

The use of the heat in the flue gases to preheat the air is a matter of easy arrangement—particularly if a steel tube preheater is used, as at the Research Station. It is possible that a slight positive pressure may be required at the inlet of the preheater, in order to assist the chimney draught; but by arranging this suitably it should be possible to reduce the pull, and therefore the size of the chimney, to some extent. There are, however, practical limits to the degree of preheat which can be applied to the air. These are reached, in the case of a steel preheater, when the tubes are heated much over 550° C. In the case of a brickwork preheater, the limit would be the size and weight of the erection.

There remains the superheating of steam as a means of conserving this waste heat. This certainly might be carried out as an addition to air preheating; but whether it would be advantageous to substitute the former for the latter when the steam is to be used in the retorts, is a matter for further experiment. The superheating of the steam supplied to the retorts has nothing to recommend it as a means of preventing condensation in the coke, or escape of steam from the coke chambers. The temperature of the coke never fell so low as 200° C. in the Research Station experiments, until after it entered the skips.

Little difficulty has been met with at the Research Station in using scrubbed coal gas as fuel gas in the settings. In these days of heavy labour costs, it seems possible that, given a satisfactory market for coke, it might be economical to use this gas instead of making use of producers with their difficulties of clinker and ash. It is not suggested that the present arrangements for supplying air and fuel gas into the combustion chambers are altogether suitable for coal gas; but the alterations necessary seem possible, while a new design for future construction, which would be suitable for either, appears to be a simple matter.

At the Research Station, owing to the low price obtainable for coal gas compared with the cost of water gas, it is the custom to change-over to coal gas whenever it is not absolutely necessary to keep the consumption of fuel gas, &c., constant, which, of course, is essential during every test. The gas and air dampers certainly require most careful setting when using coal gas, if overheating is to be avoided, and yet complete combustion obtained; but when once set, no further alteration is required, so long as the quality of the gas remains constant.

Application of Graphs to Any Individual Setting.

Comparison of Water Gas and Producer Gas.—The graphs as drawn apply to a setting which is fitted with an air preheater, and in which water gas is used as fuel; the water gas being at atmospheric temperature. These three points must be taken into consideration when making use of the results in connection with settings where the arrangements are different.

In order that these graphs may be applied to a setting in which producer gas is used for built-in producers, and in which there is no superimposed preheater, two characteristic producer gases have been considered.

	Uddingston Gas Company.		South Metropolitan Gas Company.
CO_2	6·6	..	5·0
O_2	0·6	..	0·0
CO	25·2	..	26·0
H_2	10·7	..	4·5
CH_4	0·3	..	0·5
N_2	56·6	..	64·0
	100·00	..	100·00
Temperature ° C.	650	..	920

For the details of the calculation, Appendix II. must be referred to; but it appears that in the first case the allowance of 25 p.ct. must be added to the therms of blue water gas shown in the graph, and in the second case the quantity of 21 p.ct. must be similarly added.

It is thought that this information should be sufficient to enable any gas engineer to make the graphs suit his own case

TABLE 7.—*Analyses of Gases.*

Coal	Consett.			Mitchell Main Gas Nuts.					Lanarkshire Main and Ell.	
Test No.	A.	B.	C.	D.	E.	F.	G.	H.	J.	K.
Steam, per cent.	*Nil*	5·24	20·95	*Nil*	5·06	12·44	20·53	30·05	*Nil*	22·05
Coal gas—										
CO_2	0·95	1·75	4·40	0·80	1·40	3·50	4·50	5·50	2·30	7·35
C_nH_m	2·00	2·40	2·10	2·20	2·15	1·70	1·80	1·50	2·10	1·85
O_2	0·25	0·40	0·25	0·60	0·70	0·60	0·30	0·55	0·40	0·60
CO	8·10	9·05	12·60	7·40	11·30	15·50	17·80	19·75	11·40	18·80
H_2	58·70	56·15	57·20	52·00	49·65	50·75	51·60	49 55	49·50	50·40
CH_4	24·20	23·80	19·20	29·05	25·90	21·00	18·00	16·40	25·35	15·90
N_2	5·70	6·40	4·10	7·95	8·90	6·70	5·80	6·50	8·70	5·05
	99·90	99·95	99·85	100·00	100·00	99·75	99·80	99·75	99·75	99·95
Ammonia in grms. per 100 c.ft.	3·9	2·5	15·3	*Nil*	4·5	*Nil*	8·0	0·8	0·5	1·2
Calorific value in B.Th.U. per cubic foot saturated, 60° F. and 30 in.—										
Gross	510	518	463	544	517	477	460	432	518	432
Net	451	462	410	476	460	424	410	385	467	386
Specific gravity (air = 1)	0·347	0·394	0·393	0·370	0·410	0·428	0·442	0·446	0·414	0·477
Fuel gas—										
CO_2	1·40	1·65	2·25	3·00	1·80	1·40	1·30	3·10	1·40	3·20
O_2	0·55	0·30	0·20	0·40	0·10	0·60	0·20	..	0·15	0·15
CO	47·00	46·80	46·90	43·90	47·40	47·70	47·70	43·85	46·10	44·30
H_2	46·50	46·70	46·85	43·55	44·05	44·00	43·20	45·05	45·40	45·30
CH_4	0·35	0·55	0·50	1·10	0·80	1·10	1·70	1·10	0·35	0·50
N_2	5·10	3·90	3·30	7·90	5·50	5·20	5·65	6·05	6·60	6·30
	100 00	99·90	100·00	99·85	99·65	100 00	99·70	99·75	100·00	100·00
Calorific value B.Th.U. per cubic foot saturated, at 60° F. and 30 in.	300	302	301	308	302	310	311	301	306	301
Flue gas—										
CO_2	17·70	16·70	16·90	16·10	16·2	16·60	15·6	16·5	15·0	17·1
O_2	2·20	3·24	3·55	3·90	3·6	3·70	4·8	3·9	5·6	3·4
CO	0·25					0·02				
H_2	0·10	80·06	79·55	80·00	80·2	0·03	79·6	79·6	79·4	79·5
N_2	79·75					79·65				
	100·00	100·00	100·00	100·00	100·0	100·00	100·0	100·0	100·0	100·0

TABLE 8.—*Yields and Weight Balances.*

Coal	Consett.			Mitchell Main Gas Nuts.					Lanarkshire Main and Ell.	
Test No.	A.	B.	C.	D.	E.	F.	G.	H.	J.	K.
Steam to retorts per cent. by weight of coal	*Nil*	5 24	20·95	*Nil*	5·06	12·44	20·53	30·05	*Nil*	22·05
Yields per ton of coal as charged—										
Coke, in cwts.	15·04	15·00	14·78	14·46	13·88	13·30	13·24	12·76	12·24	10·99
Gas in cubic feet satd. at 60° F. and 30 in.	13,260	13,590	17,080	13,100	16,430	20,060	22,580	25,610	11,800	18,450
Tar, in gallons (dry)	8·36	8·90	10·0	9·34	11·60	11·22	12·47	12·56	14·10	17 87
Liquor, total in gallons.	23·96	29·65	50·30	26·35	26·78	31·15	42·30	46·60	47·90	70·20
Liquor, excluding water to scrubber	10·53	16·40	37·93	15·63	15·15	23·40	31·00	39·95	37 00	58·10
Ammonium sulphate (pure) in lbs. in liquor	14·65	17 30	20·00	16·27	18·75	21·80	21 20	21·95	32·60	43·90
Ammonium sulphate escaping in gas	0 30	0·20	1·45	..	0·41	..	1·00	0·15	0·06	0·13
Weight balance—										
Coal as charged, lbs.	111,406	113,000	112,114	112,920	111,161	114,904	111,271	112,617	87,777	93,417
Steam to retorts ,,	..	5,922	23,409	..	5,627	14,293	22,846	33,836	..	20,597
Water to scrubbers ,,	6,681	6,608	6,179	5,406	5,772	3,970	5,610	3 345	4,143	5,006
	118,087	125,530	141,702	118,326	122,560	133,167	139,727	149,798	91,920	119,020
Yields in lbs.—										
Coke, dry	83,708	84,746	81,663	81,676	77,250	76,450	73,682	71,934	53,666	51,315
Gas, satd. at 60° F. and 30 in.	17,422	20,566	25,451	18,554	25,436	33,440	37,685	43,700	14,570	27,988
Tar, dry	4,822	4,964	5,505	5,163	6,323	6,379	6,762	6,986	5,970	8,005
Liquor, total	12,103	15,169	25,661	13,540	13,483	16,246	21,257	23,670	19,040	29,632
Loss	32	85	3,429	−607	68	652	341	3,508	−1,326	2,270
	118,087	125,530	141,702	118,326	122,560	133,167	139,727	149,798	91,920	119,020
Loss per cent. on total weight added to system	0·03	0·07	2·42	−0·51	0·06	0·49	0·24	2·34	−1·44	1·91

which would probably approximate to one or other of these typical producer gases.

"*Heat Equivalent*" *for any Industrial Setting.*—The simplest and probably the most accurate method of obtaining the "heat equivalent" in any particular instance is to carry out a test on similar lines to that in which the heat losses from the setting were determined at the Fuel Research Station. The test, of course, must be performed at the temperature corresponding to that in the graph which it is intended to use. The only calculations will be those necessary to obtain the total therms of heat supplied to the setting in the form of fuel gas; and also, should any of the coke charged into the retorts have been consumed, the heat evolved in the combustion of this coke to carbon monoxide must be ascertained, and added to the heat in the fuel gases.

The heat equivalent may be arrived at, though less satisfactorily, by difference. The total heat supplied to the setting and retorts per hour in the form of gas and steam, in order that the required carbonizing temperature may be maintained, must be accurately measured. From this is deducted the heat required for carbonization as indicated in the graph. The difference is the "heat equivalent" of the setting. Having once obtained the heat equivalent for any particular setting, by simple substitution in the graph of whatever coal may be in question (allowance, if any is required, being made for producer gas instead of water gas), the complete results of steaming in those retorts may be read up to any percentage to which the graph reaches.

In order to carry out a comparison with the Uddingston results, it was necessary to obtain the heat equivalent of the Research Station setting at a lower temperature—1210° C., instead of 1260° C. This was found to be 9·6 therms per hour, using water gas. By making use of this figure in test "J," and transferring into No. 1 test, Uddingston, the heat required to bring about the carbonization of the coal and carry off the products at working temperatures, it appears that the Uddingston heat equivalent must be about 8·4 therms.

When carbonizing Lanarkshire coal, this figure of 8·4 therms

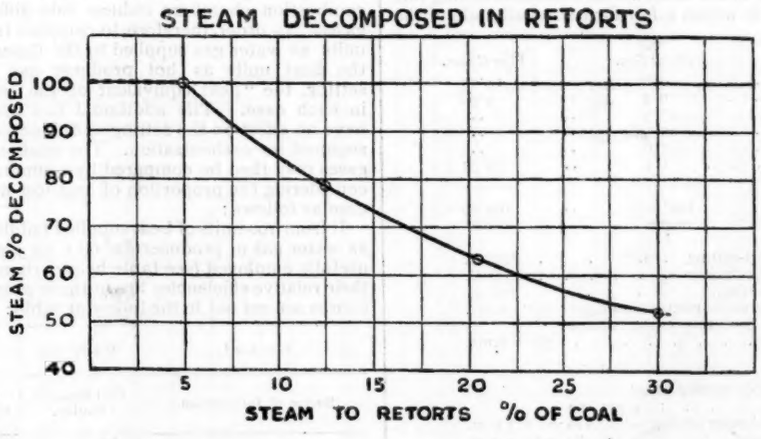
TABLE 9.—*Heat Efficiencies of Carbonisation.*

Coal.	Consett.			Mitchell Main Gas Nuts.					Lanarkshire Main and Ell.	
Test No.	A.	B.	C.	D.	E.	F.	G.	H.	J.	K.
Steam per cent.	*Nil*	5·24	20·95	*Nil*	5·06	12·44	20·53	30·05	*Nil*	22·05
Heat in water gas per hour (therms)	17·97	16·76	19·02	19·15	16·80	19·28	20·65	22·42	18·36	19·60
Heat in steam (therms)	..	0·55	2·21	..	0·53	1·35	2·15	3·20	..	3·44
	17·97	17·31	21·23	19·15	17·33	20·63	22·80	25·62	18·36	23·04
Heat carried off in flue gases (therms)	4·90	4·25	5·50	5·31	4·77	5·46	6·35	6·63	5·05	4·93
Heat dissipated from retort settings (therms)	8·37	8·37	8·37	8·37	8·37	8·37	8·37	8·37	6·23	5·00†
Heat dissipated from preheater setting (therms)	0·96	0·87	1·13	1·33	1·09	1·40	1·36	1·46	0·83	1·44
Total	14·23	13·49	15·00	15·01	14·23	15·23	16·08	16·46	12·11	11·37
Heat taken up by coal (therms)	3·74	3·82	6·23	4·04	3·11	5·40	6·72	9·16	6·25	12·45
Heat taken up by coal per cent. of heat added	20·8	22·0	29·3	21·1	17·9	26·2	29·4	35·7	34·0	56·4
Coal carbonised per hour (tons)	0·415	0·420	0·417	0·420	0·413	0·427	0·414	0·419	0·544	0·614
Heat taken up by coal per ton (therms)	9·01	9·10	14·95	9·62	7·53	12·65	16·23	21·86	11·50	20·28
Temperature of gas, tar, and liquor leaving retort	240° C.	310° C.	..	210° C.	220° C.	270° C.	330° C.	430° C.	127° C.	146* C.
Temperature of coke discharged	..	..	..	460° C.*	420° C.*	410° C.	310° C.	270° C.	425° C.	274° C.
Heat returned by preheater	1·83	1·73	1·63	1·74	1·75	1·87	2·10	2·28	1·49	1·51

* Air used to prevent bottom casting becoming overheated. † Estimated value.

TABLE 10.—*Effect on Composition of Gas by Steaming Mitchell Main Coal.*

Test No.	D.	E.		F.		G.		H.	
Steam per cent.	*Nil*	5·06		12·44		20·53		30·05	
Constituent gases (cubic feet per ton)—									
CO_2	105	230	125	702	597	1,018	913	1,410	1,305
C_nH_m	288	354	66	341	53	407	119	385	97
O_2	79	115	36	120	41	68	−11	141	62
CO	970	1,858	888	3,110	2,140	4,020	3,050	5,060	4,090
H_2	6,812	8,157	1,345	10,080	3,368	11,656	4,844	12,700	5,888
CH_4	3,805	4,255	450	4,213	408	4,066	261	4,200	395
N_2	1,041	1,461	420	1,344	303	1,310	269	1,664	623
	13,100	16,430	3,330	20,010	6,910	22,545	9,445	25,560	12,460
Excess gas over dry carbonisation—									
CO_2			3·7		8·6		9·7		10·5
C_nH_m			2·0		0·8		1·3		0·8
O_2			1·1		0·6		..		0·5
CO			26·7		31·0		32·3		32·8
H_2			40·4		48·7		51·2		47·3
CH_4			13·5		5·9		2·7		3·2
N_2			12·6		4·4		2·8		4·9
			100·0		100·0		100·0		100·0
Calculated calorific value gross B.Th.U. per cubic foot saturated at 60° F. and 30 in.	..		401		337		325		311
Equivalent weight of water = excess hydrogen in gas tar and sulphate (lbs.)	717		115		219		293		352
Steam to retorts lbs.	..		114		278		460		672
Steam gasified per cent.	..		100·0		78·8		63·7		52·3



per hour (using producer gas), for a bench setting of eight retorts with straight-through combustion chambers, amounts to 28·9 p.ct. of the total heat supplied to the setting for a throughput of 3¼ tons per retort per day, and compares with the 9·6 therms or 53·7 p.ct. of total heat supplied (using water gas) for an isolated setting of four retorts with flues encircling each pair of retorts.

It seems probable that, in an ordinary bench-setting of eight retorts of this type, the heat equivalent for a temperature of 1210° C. will be about 8·4 therms per hour using producer gas. This should be given by about 0·8 cwt. of coke per hour in the cases of the two producer gases mentioned in Appendix III., allowing 15 p.ct. of ash in the coke.

If the temperature is kept up to 1260° C., the heat equivalent for this setting will probably amount to 10·9 therms per hour, using producer gas which should be given by 1·1 cwt. and 1·2 cwt. of coke in the cases mentioned above.

APPENDIX I.

The first appendix gives details of the sampling, testing, and analysis connected with the work reported upon. It concludes with the following particulars of special tests carried out during the investigation,

Special Tests.

Calorific Values.—All calorific values were determined in a bomb calorimeter of the Berthelot Mahler type. In the case of coke, the difficulty of ignition was overcome by using as a primer a pellet of pure benzoic acid of known calorific value. Even with this a certain amount of carbon sometimes escaped combustion, and had to be allowed for by igniting the dried crucible after the experiment, and taking the loss in weight as carbon.

Distillation of Tar.—The average sample of crude tar was distilled in the laboratory in a small cast-iron still of about two litres capacity, and fractions collected to 230° C., 230° to 270° C., and 270° to 310° C. The original tar was weighed into the still, and the fractions were weighed. The results obtained were calculated to dry tar, and benzene and toluene estimated in the first fraction by the method described by Dr. Colman in his pamphlet "Determination of the Percentage of Benzene, Toluene, and Xylene in Commercial Toluol." *

The water in the tar was independently estimated by the distillation of 100 grams. of tar with 200 c.c. of xylol.

Tar in Liquor.—When occasion arose, the amount of free tar in the liquor was determined simply by the separation of about 5 gallons for 48 hours, and the weighing of the separated tar.

APPENDIX II.

Test for Determination of Heat Losses from Setting.

In this special test it was arranged that there should be no consumption of heat in the system other than that required to overcome the losses due to radiation, conduction, and convection from the setting, and that carried off as sensible heat in the flue gases. The latter loss was calculated from the composition of the fuel and flue gases; and after deducting this from the total heat supplied to the setting, the balance was attributed to the former causes.

The procedure followed was that the retorts were filled with coke and kept steadily at the normal working temperature (1260° C.), while observations were made of the fuel consumption and the composition of the flue gases. The temperatures of the flue gases leaving the retort and leaving the preheater, and of the air entering the setting, were carefully measured.

The distribution of heat was calculated at each of these points per 100 cubic metres of water gas, and a heat balance (see below) was made out. The sensible heat in the calculated volume of flue gas leaving the preheater was first determined, then the heat in the inlet air on entering the setting after passing through the preheater, and, finally, the heat in the flue gas leaving the retort-setting before entering the preheater. The heat lost in the preheater itself was taken as the difference between the third and second items.

Having expressed these as percentages of the heat supplied, from the hourly consumption of gas figures were then obtained showing the distribution of heat per hour (see below).

During the test, it was found that some of the coke in the retorts was being consumed; and a correction had to be made to allow for this. This was effected by weighing the coke before and after the test, estimating the loss in weight as carbon, and assuming that it would be consumed to CO. The heat thus liberated was added to the figure given for losses by radiation, &c., from the retort-setting.

The mean temperature of the combustion chambers during this test was 1266° C., which is within a few degrees centigrade of the carbonizing tests.

Composition of Gases.	Water Gas.		Flue Gases.
CO_2	0·8	..	14·75
O_2	0·4	..	5·90
CO	47·5	..	..
H_2	45·3	..	..
CH_4	1·6	..	..
N_2	4·4	..	79·35
	100·00	..	100·00

Temperatures in System.	
Flue gas leaving retort-setting	843° C.
,, ,, ,, air preheater	413° C.
Air entering retort-setting	376° C.
Volume of air per 100 cubic metres water gas	331·1 c.ms.
,, ,, flue gas per 100 cubic metres water gas	387·6 c.ms.

Heat Balance.	Calories.	
Total heat in 100 cubic metres water gas	275,000	
Total heat lost in preheater setting =	23,540 =	8·5 p.ct.
,, ,, ,, retort =	183,280 =	66·7 p.ct.
,, ,, ,, 387·6 cubic metres flue gas =	68,180 =	24·8 p.ct.
	275,000	100·0 p.ct.
Total heat returned by preheater. =	34,200 =	12·4 p.ct.
Water gas burned per hour =	3911 c.ft.	
=	110·7 c.ms.	
Heat value =	304,200 cals.	
Heat expended by combustion of coke in retorts (per hour) =	8170 cals. =	2·7 p.ct. of heat in fuel.

* H.M. Stationery Office.

Heat Losses per Hour from Setting.	Calories.	Therms.
By radiation, &c., from retort-setting (including combustion of coke). =	210,870	8·37
By radiation, &c., from preheater =	26,050	1·03
By sensible heat in flue gases =	75,480	3·00
Total =	312,400 or	12·40

The total heat per hour required to maintain the whole plant at its working temperature is the sum of all the heat losses above, and amounts to 12·40 therms per hour.

The value of 8·37 therms may be taken as an approximate figure for the amount of heat lost by radiation, conduction, and convection from the walls of the retort during any test in which the same carbonizing temperature is employed. Assuming this figure to be constant, therefore, a value may be worked out in each test for the net amount of heat required to carbonize the coal and remove the products of distillation at the working temperature.

The results obtained by this method of calculation are shown in Table 9, as well as the temperatures (approximate) at which the products are removed.

APPENDIX III.

Comparison of Heating Values of Water Gas and Producer Gas to Admit of the Substitution of the Latter for the Former in Figs. II., III., and IV. and Calculations.

In all the tests carried out at the Research Station, the fuel used was water gas of as constant composition as possible. As this would, in gas-works practice, be replaced by producer gas supplied from a built-in setting, it is obvious that the amount of heat consumed in keeping the setting at the working temperature would be quite different. In order to arrive at a basis of comparison from which the results given in the graphs (figs. II., III., and IV.) would become immediately useful, the following typical producer gases have been considered. The temperatures at which these gases enter the settings are working figures obtained under normal conditions.

Gas Used.	Water Gas.	Producer Gas.	
Source of Information.	Fuel Research Station.	Uddingston Gas Company.	South Metropolitan Gas Company.
CO_2	2·25	6·6	5·0
O_2	0·20	0·6	0·0
CO	46·90	25·2	26·0
H_2	46·85	10·7	4·5
CH_4	0·50	0·3	0·5
N_2	3·30	56·6	64·0
	100·00	100·00	100·00
Calorific value calculated. B.Th.U. per c.ft. saturated at 60° F. and 30 in.	310	120	104
Temperature of gases entering setting	Atmospheric	650° C.	920° C.

If it is assumed that heat losses by radiation, &c., are approximately constant, then the amount of heat which will require to be added to the setting will be greater with producer gas than with water gas, owing to the larger proportion of sensible heat carried away in the waste gases from the former. As the producer gas is generally used hot, the sensible heat carried into the combustion chambers reduces this difference between the two gases. In order, therefore, to compare the efficiencies of the heat units as water gas supplied to the Research Station setting and the heat units as hot producer gas supplied to any other setting, the "heat equivalent of the setting" must be known in each case. The additional fuel added may be assumed to have no effect on the setting and to act solely to supply the heat required for carbonization. The relative efficiencies of the three gases may then be compared by assuming 10 p.ct. excess air, and considering the proportion of heat lost in the waste gases in each case as follows:

If from 100 units of heat supplied (additional to heat equivalent) as water gas or producer gas 68·1, 54·3, and 56·2 respectively are usefully employed (see table below), then it may be assumed that their relative efficiencies are in these proportions. Comparative figures are set out in the following table:

Gas Used.	Water Gas.	Producer Gas.	
Source of Information.	Fuel Research Station.	Uddingston Gas Company.	South Met. Gas Company.
Calorific value B.Th.U. per cubic foot	310	120	104
Temperature of fuel gas.	Atmos.	650° C.	900° C.
Equivalent increase due to sensible heat	*Nil*	19 p.ct.	32 p.ct.
Temperature of waste gases.	520° C.	920° C.	920° C.
Heat lost in waste gases as percentagr of total heat in fuel gas	31·9	45·7	43·8
Equivalent values: In heat units	1	1·25	1·21
In volumes	1	3·23	3·61

In actual heat units, therefore, there is very little difference between the efficiencies of the two producer gases; the gas obtained with no steaming being slightly better than the other. Water gas, on the other hand, is more efficient than either when the special preheater is used, as in the Research Station setting.

To apply these results to figs. II., III., and IV., it is necessary to know the heat equivalent of the installation in question, and, starting with this as a base line, express the therms of heat added as 121 to 125 p.ct. of those given for water gas, according to which producer gas sample comes nearest in composition to that actually used.

APPENDIX IV.

STEAMING VERTICAL RETORTS COMPARED WITH GENERATION OF ENRICHED WATER GAS IN SEPARATE GENERATOR.

In considering the quantity and calorific value of enriched water gas which will take the place of the "excess" gas produced in the vertical retorts by means of steaming, it has been decided to consider only the South Yorkshire coal, and to make use of a graphic method of representation.

In all the graphs the abscissæ are in terms of therms of gas produced per ton of coal additional to the production when carbonizing without steam (the "excess" gas in therms).

In fig. V. are shown the calorific value of this "excess" gas (plain), and also the volume of the same (dotted). These graphs, of course, also represent the calorific value and volume of enriched

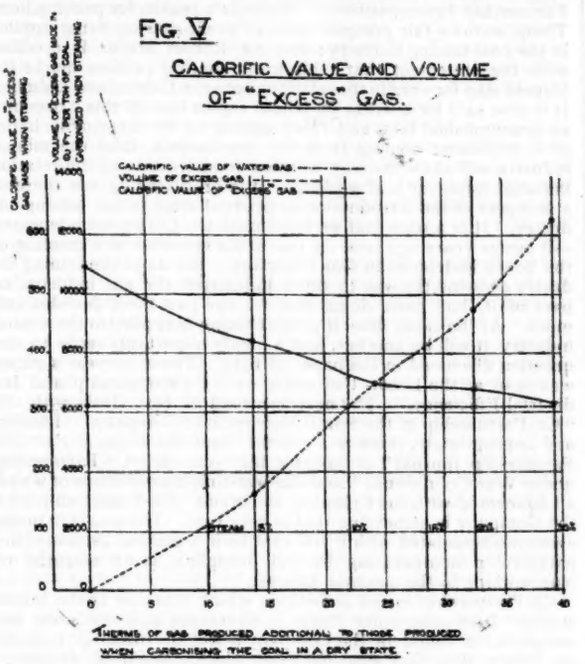


FIG. V
CALORIFIC VALUE AND VOLUME OF "EXCESS" GAS.
CALORIFIC VALUE OF WATER GAS
VOLUME OF EXCESS GAS
CALORIFIC VALUE OF "EXCESS" GAS
STEAM
THERMS OF GAS PRODUCED ADDITIONAL TO THOSE PRODUCED WHEN CARBONISING THE COAL IN A DRY STATE.

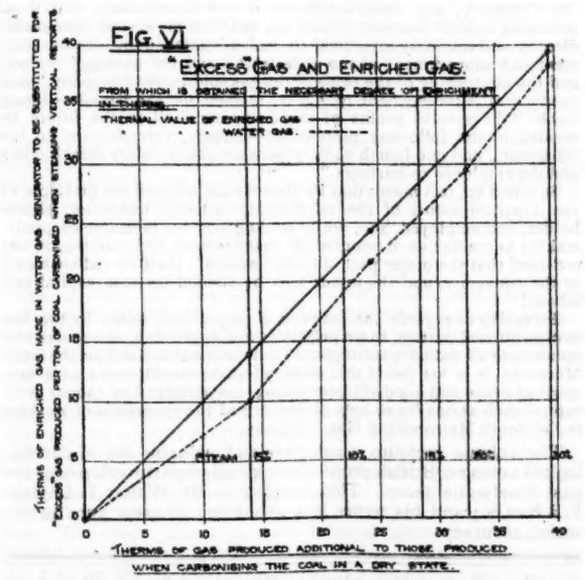
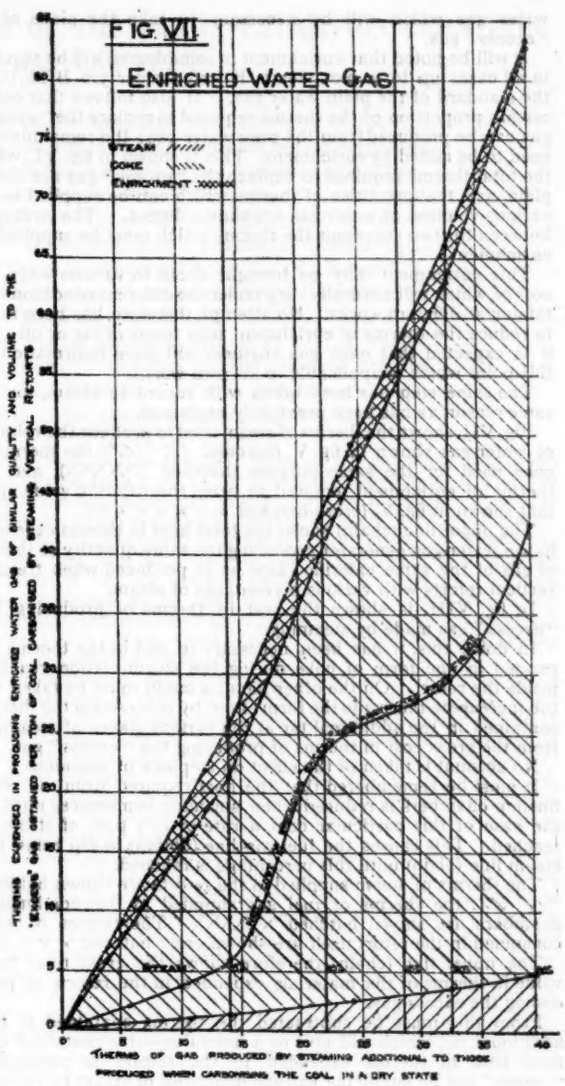


FIG. VI
"EXCESS" GAS AND ENRICHED GAS.
THERMAL VALUE OF ENRICHED GAS
WATER GAS
STEAM
THERMS OF GAS PRODUCED ADDITIONAL TO THOSE PRODUCED WHEN CARBONISING THE COAL IN A DRY STATE.



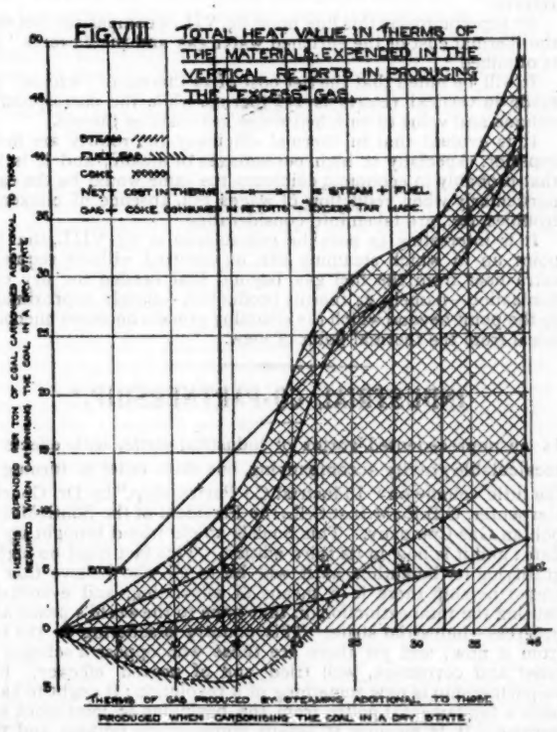


FIG. VIII
TOTAL HEAT VALUE IN THERMS OF THE MATERIALS EXPENDED IN THE VERTICAL RETORTS IN PRODUCING THE "EXCESS" GAS.
STEAM
FUEL GAS
COKE
NETT COST IN THERMS
= STEAM + FUEL GAS + COKE CONSUMED IN RETORTS − "EXCESS" TAR MADE.
STEAM
THERMS OF GAS PRODUCED BY STEAMING ADDITIONAL TO THOSE PRODUCED WHEN CARBONISING THE COAL IN A DRY STATE.

FIGS. V. TO VII. WERE PREPARED FOR USE WITH APPENDIX IV. THEY SHOW THE COMPARATIVE EXPENDITURE IN THERMS WHICH IS NECESSARY TO PRODUCE ENRICHED WATER GAS OF SIMILAR VOLUME AND CALORIFIC VALUE TO THE "EXCESS" GAS PRODUCED WHEN STEAMING VERTICAL RETORTS.

water gas which will be necessary to take the place of the "excess" gas.

It will be noted that enrichment in some degree will be required in all cases up to 30 p.ct. steam, if we consider 310 B.Th.U. as the standard of the plain water gas. It also follows that only a certain proportion of the therms required to replace the "excess" gas can be produced from the pure water gas; the remainder will need to be added by enrichment. This is shown in fig. VI., where the total therms required to replace the "excess" gas are shown plain, and the quantities of therms which can be supplied in the various volumes of water gas are shown dotted. The ordinates between the two represent the therms which must be supplied by enrichment.

This enrichment may be brought about in various ways, the cost of which will naturally vary under the different conditions obtaining at different works. No attempt, therefore, has been made to reduce the therms of enrichment into terms of tar or oil; but it is expected that each gas engineer will have information on this point which is applicable to his own works.

The same step has been taken with regard to steam, for the same reason as has been previously explained.

Fig. VII. shows the therms of steam used to produce the volumes of water gas shown in fig. V. (hatched //////), the therms of coke used for the same purpose (hatched \\\\\\), and the therms of enrichment required to bring the calorific value up to that shown in fig. V. (cross-hatched ××××××).

The upper line (chain) shows the total heat in therms expended in the water-gas generator producing the same quantity of therms of gas of the same calorific value as is produced when treating vertical retorts with various percentages of steam.

In fig. VIII. is shown the cost in therms of producing the "excess" gas made by steaming.

In doing this, it has been necessary to add in the therms expended in the form of coke during the steam-carbon reaction inside the retort. On the other hand, a credit must be taken for the increase in therms in the form of tar, by subtracting the therms contained in the additional tar at the various stages of steaming from the gross cost in therms of producing the "excess" gas.

No account is taken of the effect on sulphate of ammonia.

It must be remembered that the heat required from the combustion chambers is reduced when steaming commences until, in the case of this particular coal, a rate of 11·5 p.ct. of steam is reached. This causes the fuel-gas line (dotted) to dip below the steam line (plain) until this percentage is reached.

The therms of steam supplied to the retorts are shown hatched //////, the therms of fuel gas supplied to the combustion chambers are shown hatched \\\\\\. The therms of coke consumed in the retort itself are shown cross-hatched ××××.

The upper line (chain) therefore shows the gross total heat value in therms of the materials expended in the retorts in producing the excess gas.

From this must be subtracted the therms contained in the additional tar, which will give us a net value—star chain—of the total heat in therms expended in the retorts in producing "excess" gas by supplying various quantities of steam to vertical retorts.

By superimposing this line upon fig. VII., a comparison between the thermal cost of the enriched water gas and the "excess" gas is obtained.

It will be noted that the net cost of 24 therms of "excess" gas made in vertical retorts is 25½ therms, while the corresponding volume and value of enriched water gas costs 49 therms.

It is evident that in thermal efficiency the retorts are much superior, especially at high percentages of steam; and it is felt that probably in economic efficiency the same would be the case, particularly when reduction of wages bill, absence of clinkering troubles, &c., are taken into consideration.

It is interesting to note the coincidence in fig. VIII., that the point up to which steaming can be resorted without requiring extra heat from the fuel gas beyond that needed for dry carbonization—namely, 24 therms production—closely approximates to the point beyond which the steaming process becomes uneconomical from the thermal point of view.

INDUSTRIAL CO-PARTNERSHIP.*

In an unprecedented vortex of industrial strife, with effects of incalculable gravity accompanying, one finds relief in turning to the little volume on "Industrial Co-Partnership," by Dr. Charles Carpenter, C.B.E., M.Inst.C.E., the President of the South Metropolitan Gas Company. This book is an old friend brought up to date; and it is now in its third edition. This fact must be highly gratifying to the author, as it will be to all who believe that in co-partnership there is a means of alleviating, and eventually causing the total extinction of, that bane to the world's peace and progress—industrial strife. This country is suffering to the full from it now; and yet there are those who oppose a scheme of relief and correction, well tried and of proved efficacy. But co-partnership is now something of a revolution; it ought to have been a fundamental policy from the beginning of joint-stock enterprise. It is because it assails conservative notions and the conditions into which we have drifted, of organized sides (which fortunately are being brought, by conference, to better mutual understandings), that a system which might have before amalgamated the interests of employer and employed, has been by the major part of industry kept outside their arbitrary drawn ambit of practical politics. However, we see an increasing interest. One piece of evidence is that the third edition of this little book is called for.

The volume is really a collection of papers that Dr. Carpenter has read on various occasions before different influential bodies. From the literary point of view these papers are faultless; but, more important still, the material of which they are composed is the essence of upwards of thirty years' study of co-partnership principles and effects, and experience of the effects of the application of the principles in the case of the South Metropolitan Gas Company. But the study is not confined to that Company. The considerations that are brought out in the papers extend beyond the single, although imposing, instance. With Dr. Carpenter co-partnership is not a mere question of policy; it is with him a belief—something that is right and just, something that not only improves the workers' position monetarily, but is an animating power in giving them a broader outlook on life, and assisting in moral development. All this is something that is of advantage not only industrially, but nationally. The series of papers commences with one on "Co-Partnership in Industry," read at Balliol College, Oxford, in 1911. In the second, read in 1913, the question is discussed, "Are Trades Unionism and Co-Partnership Incompatible?" There is a reason for pausing here. There seems a fair prospect now of profit-sharing being applied in the coal-mining industry; and Sir Robert Horne is credited with the statement that "this profit-sharing scheme marks the biggest step forward in the relations between Capital and Labour." It is also said by a writer on labour topics that if this "becomes an accomplished fact, and there appear to be reasonable hopes of a settlement coming from the negotiations, then the mining industry will show the way to other industries as to the relation between employer and worker." It is gratifying to see there is a prospect of the introduction of profit-sharing in the mining industry. It is a plan that we remember Dr. Carpenter advocated—it seems years ago now—in one of his speeches at a meeting of the South Metropolitan Gas Company. But as to the mining industry showing the way to other industries, the gas industry, or part of it, has been doing that for the past three decades and more. At the same time, if profit-sharing is applied to the mining industry, it will be another, and a highly important, reply to the question discussed in the paper of 1913. The same year a paper was read at the Leeds University on "Co-Partnership and Industrial Efficiency." The next one, read in 1918, deals with the "Co Partnership of the South Metropolitan Company." Finally, and appropriately, there is a reprint from the Company's "Co-Partnership Journal" of January last year on "Co-Partnership under War Conditions;" and the war-time record is one of which all connected with the Company are proud. Co-Partnership with the Company is something that is very real. The aim is to make everyone associated with it feel that he is a partner *de facto*—the partnership incorporating the best discipline as an essential to true working in the common interest.

Co-Partnership is not something which remains at the initial stages. Like most other things, it develops; and the latest development is found in the Company's Act of 1920. A page in the volume describes what has taken place. We quote from it:

> The Act refers in its preamble to the desirability that "new provisions should be made with a view of securing that the public supplied by the Company, and those employed in the undertaking, and those providing capital therefor, should be, and that more than heretofore, directly and mutually interested in, and advantaged by, the development and improvement of the undertaking and the earnings thereof, and the cheapening of the price of the gas sold by the Company," and enacts that, after payment of 5 p.ct. interest on the issued ordinary stock, "the surplus profits of the Company shall in the future be divided in the following proportions—namely, three-fourths to the consumers, and one-fourth equally between the ordinary stockholders and the employee co-partners."
>
> Summed up, this means that Parliament has adopted the principle of the tripartite nature of the relationship between consumer, shareholder, and employee, and, while holding out the incentive of profit-making as conducive to economical management and working, it has ordained that the major part of such "wealth" shall be redistributed to the consumer, and the minor part be divided between capital and labour.
>
> Excepting as regards the proportion respectively taken by the last two mentioned parties, these principles are applicable, in the writer's opinion, to all industry throughout the length and breadth of the land. Moreover, it is his belief that their adoption would result in a new spirit of peace and goodwill permeating the relations of labour with capital such as has for so long characterized the thousands of workers in the South Metropolitan Gas Company.

The volume includes a complete and valuable set of chronological notes on British profit-sharing and co-partnership over the past ninety-one years. The compiler is Mr. Walter T. Layton, F.R.Hist.S.; and his name is a guarantee of great care in ensuring accuracy.

* "Industrial Co-Partnership," by Charles Carpenter, C.B.E., D.Sc., M.Inst.C.E. London: Co-Partnership Publishers, Ltd. Price (in paper covers) 1s. 6d.

The marriage took place at Whickham Parish Church, on the 11th inst., of Thomas Percy, son of the late Mr. and Mrs. T. D. Ridley, of Newcastle-on-Tyne, to Winifred Mary, elder daughter of the Rev. and Mrs. C. E. Little.

SIXTH REPORT OF THE RESEARCH SUB-COMMITTEE OF THE GAS INVESTIGATION COMMITTEE OF THE INSTITUTION OF GAS ENGINEERS.

WE commence to-day the publication of the Sixth Report of the Research Sub-Committee of the Gas Investigation Committee which was to have been submitted last month to the Institution of Gas Engineers. Publication of the fifth report will follow. The members of the Research Sub-Committee are: Chairman: Prof. Arthur Smithells, C.M.G., B.Sc., F.R.S. Representatives of the University of Leeds: Prof. J. W. Cobb, C.B.E., B.Sc., F.I.C. (Hon. Secretary), Prof. J. B. Cohen, Ph.D., F.R.S., and Mr. G. R. Thompson, B.Sc. [One vacancy.] Representatives of the Institution of Gas Engineers: Messrs. H. E. Bloor, B.Sc., B.Eng., John Bond, O.B.E., J. H. Brearley, M.Inst.C.E., Thomas Glover, O.B.E., M.Inst.C.E., C. Wood, O.B.E. Mr. T. F. E. Rhead, M.Sc., was co-opted a member of the Research Sub-Committee for the purpose and period of research work at Birmingham. Research Chemists: Messrs. W. Wood, M.Sc. (Tech.), A.I.C., on the relative efficiencies in use of different grades and compositions of gas; A. Parker, D.Sc. (Birmingham), M.Sc. (Manc.), A.I.C., on the comparative economies in production of different grades of gas. Research Assistants: Messrs. H. Kerr, A.I.C., Diploma Fuel and Metallurgy (Leeds), F. S. Townend, B.Sc.Eng. (London), and G. B. Howarth, B.Sc., Gas Engineering (Leeds), A.I.C.

INTRODUCTION.

The Joint Committee on Gas Heating, Lighting, and Ventilation Research of the Institution of Gas Engineers and the University of Leeds have continued to act as Research Sub-Committee for the Gas Investigation Committee of the Institution. The membership has been altered during the year by the resignation of Dr. E. W. Smith and the appointment of Mr. Thomas Glover in his place. Mr. H. E. Bloor has been added as an Institution representative, and Mr. T. F. E. Rhead co-opted. An additional University representative has still to be appointed.

Dr. Smith has been a member of the Committee for a long term of years, and has throughout played a very active part in their work. The Research Sub-Committee would like to place on record their regret at losing his valued co-operation. During the year the work of the Committee has been carried out in two sections under the supervision of Prof. Cobb; and separate reports—the fifth and sixth—are being issued thereon.

The first section is an investigation undertaken primarily by the invitation of the Recording Calorimeters Sub-Committee of the Institution into the accuracy and general reliability under working conditions of recording calorimeters, and particularly of the Simmance recording calorimeter. For this purpose, numerous and carefully-chosen experiments and calculations have been necessary; and the Committee have never had greater reason to thank Mr. James W. Wood, the Research Chemist, who has been immediately responsible for the work. The results are embodied in the fifth report. It was believed that the immediate importance of the subject-matter justified the suspension for a time of the work on the relative efficiencies in use of different grades of gases; but it is the intention of the Committee to take this up again at the first opportunity.

The second section of the work this year is the investigation of the blue water-gas process, which may be regarded as complementary to the investigation of steaming in continuous vertical retorts which was carried out at Uddingston and reported upon last year (fourth report). Dr. Parker was again in immediate charge of the investigation; and an attempt has been made to investigate the thermal and chemical aspects of blue water-gas production as thoroughly as was practicable. The Committee record again their appreciation of the care and skill displayed by Dr. Parker and his staff, both in the making of the necessary tests, often in very difficult circumstances, and in the treatment of the results obtained, so as to make them yield the maximum amount of information. The actual control of the plant was in the hands of Mr. G. A. Bamber, Engineer of the Gas-Works at Adderley Street, Birmingham, where the investigation was carried out.

Once more the Committee take the opportunity of expressing their thanks to the Birmingham Corporation Gas Department and their staff for the facilities they have afforded and the help they have rendered in the progress of the investigations.

SECTION I.

INTRODUCTION.

The inquiry into the thermal and chemical efficiencies of methods of manufacture of different grades of gas was commenced by an investigation of the process of steaming the charges in the retorts of the continuous vertical installation at the works of the Bothwell and Uddingston Gas Company.

The results of the Uddingston tests, which appear in the fourth report of the Research Sub-Committee, proved conclusively that, with proper control of the conditions—such as throughput of coal, temperatures of the setting, rate of admission of steam, &c.,—considerable advantages are to be gained by moderate steaming. Seven tests in all were reported; the amount of steam being gradually increased, until the last test aimed at complete gasification. The report shows that the thermal efficiency of gas production rose from 54·4 p.ct. in the first test without steam to 62·1 p.ct. in the fourth. Comparing the yields in the first and fourth tests, it is found that the make of gas per ton of dry ash-free coal increases from 11,166 c.ft. of 544 B.Th.U. gross to 21,400 c.ft. of 436 B.Th.U. gross, which corresponds with an increase in the gas multiple from 60·74 therms to 93·30 therms gross. Further, the thermal value of the gas made per retort per day rose from 159·4 to 267·0 therms gross, though the carbon dioxide content of the gas in the test with the higher make was kept down to the reasonable figure of 5·1 p.ct. At the same time, as against an equivalent of 39 lbs. of pure ammonium sulphate in the first test, 45·6 lbs. were obtained in the fourth test; and the amounts of dry tar were respectively 15·7 and 24·5 gallons. These increased yields were obtained with a reduction of less than 3 cwt. in the amount of dry coke available, after making due allowance for the extra fuel required in the fourth test for raising steam and heating the retorts.

The efficiencies obtained could undoubtedly be increased by the utilization of much of the heat carried away by the waste gases, and by adopting means for reducing the large losses in steam injected into the coke chambers. Steaming to a greater degree than that adopted in the fourth test caused a reduction in thermal efficiency. The seventh test proved definitely that, though complete gasification by steaming in continuous vertical retorts can be obtained, the process is not a commercial proposition with existing plant.

The next logical step in the investigation was to examine the process of manufacture of blue water gas as ordinarily carried out in a separate generator, in order that a comparison might be made with the method of steaming in continuous vertical retorts. The Committee desire to express their gratitude to the members of the Institution and the industry for the disposition which was shown to help the research by the offer of several water-gas installations. The installations offered, however, were mainly designed in the first instance for the production of carburetted water gas; and since it was considered that the only way to make the tests satisfactory was to carry them out on a plant specially designed for blue gas, the offer of the installation at the Adderley Street works of the Birmingham Gas Department was accepted. The Committee desire to express their appreciation of the help and facilities afforded by the Birmingham Gas Department throughout the research described in this sixth report. Mr. G. A. Bamber is the Engineer-in-Charge of the Adderley Street works; and Dr. A. Parker has been in immediate charge of the tests carried out there, assisted by Messrs. H. Kerr, F. S. Townend, and G. B. Howarth.

HISTORICAL.

It is not considered necessary to give a historical survey of the development of the manufacture of water gas; but as a preliminary to the report it is believed that a brief account of some of the more recent work on the subject would be of value.

Mr. A. G. Glasgow, in a paper read before the American Gas Light Association in 1890, gave an account of tests carried out on the thermal efficiency of a carburetted water-gas setting using anthracite as fuel. These tests yielded an over-all thermal efficiency of 80·8 p.ct.; due allowance being made for the heat value of the tar recovered, and an efficiency of gasification of 71·6 p.ct. But these figures do not include the fuel required for the generation of steam and for driving the blower. Mr. E. G. Stewart* has used Mr. Glasgow's results for the calculation of the thermal efficiency of production of blue water gas, and has thereby obtained a value of 58 p.ct., which is reduced to 43 p.ct. after allowing 9·5 lbs. of fuel per 1000 c.ft. gas made to supply steam to the generator and to drive the blower.

The manufacture of blue water gas according to the Dellwik-Fleischer system was investigated by Prof. Bone some years ago in a ten-hour test, which yielded a thermal efficiency of 65·6 p.ct.; no allowance being made in it for fuel for raising steam and driving the blower. A similar test over a period of six hours with a Kramers and Aarts installation gave a thermal efficiency of 76·6 p.ct. It can be calculated that these efficiencies, after making an allowance for the fuel to raise 70 lbs. of steam (at 70 p.ct. boiler efficiency) per 1000 c.ft. of water gas made, would be reduced to 53 p.ct. and 59 p.ct. in the tests on the Dellwik-Fleischer and Kramers and Aarts installations respectively. But these results represent the comparatively high efficiencies obtainable under the conditions operating during only a few hours; the

* See "JOURNAL," Vol. CXLIX., p. 750.

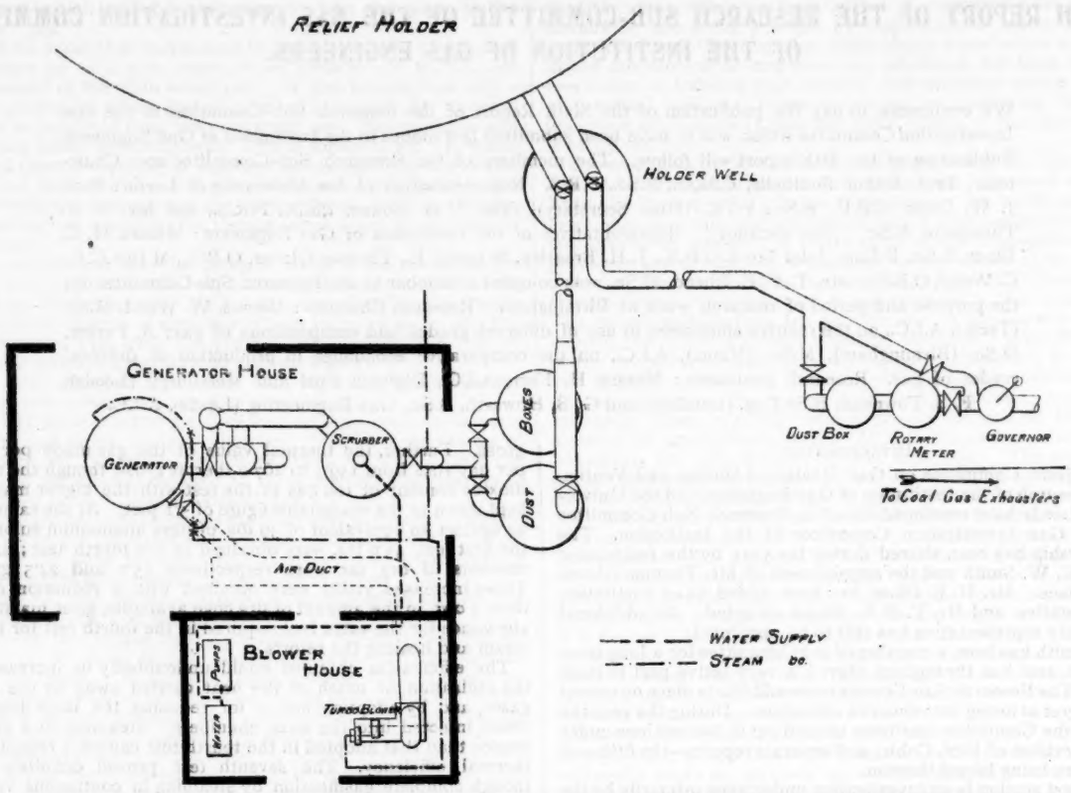


DIAGRAM I.—GENERAL ARRANGEMENT OF WATER-GAS PLANT, ADDERLEY STREET, BIRMINGHAM.

average efficiencies in everyday working are probably much lower. Reference is made in Dowson and Larter's "Producer-Gas" (1920 edition) to tests carried out on a water-gas installation at Essen, which gave the low thermal efficiency of 42 p.ct., without allowance for the fuel for raising steam and driving the blower.

Strache and Jahoda ("Journal für Gasbeleucht.," 1900 and 1904), in an extensive series of papers, which were abstracted in the "JOURNAL OF GAS LIGHTING,"* analyzed the conditions of "blow" and "run" affecting the total efficiency of water-gas production. They concluded that the maximum total efficiency is obtained with a mean temperature of the fuel bed of 880° C., at which temperature, and under the conditions of their experiments, the "blow" gas contained 9 p.ct. carbon dioxide and 19·8 p.ct. carbon monoxide, and left the generator at 380° C. During the run, 95 p.ct. of the steam was decomposed; and the resultant water gas, which contained 2·8 p.ct. carbon dioxide, left the generator at 440° C. By calculation from the results of experiments carried out separately on the "blow" and "run" periods, Strache and Jahoda concluded that it is possible to obtain an efficiency of 71 p.ct. without any allowance for fuel for raising steam and driving the blower. This efficiency would become 56 p.ct. after allowing for fuel to raise steam.

The results of the tests just mentioned are grouped together in the following list:

Thermal Efficiency of Production of Blue Water Gas.

[No allowance made for fuel for raising steam and driving blower.]

1.	Stewart's calculation from tests by A. G. Glasgow . .	58 p.ct.
2.	Dellwik-Fleischer system, 10-hours test by W. A. Bone	65·6 ,,
3.	Kramers and Aarts ,, 6-hours ,, W. A. Bone	76·6 ,,
4.	Installation at Essen	42 ,,
5.	Strache and Jahoda	71 ,,

Thermal Efficiency.

[Allowance made for fuel for raising steam and driving blower.]

1a.	Stewart's calculation from tests by A. G. Glasgow .	42 p.ct.
2a.	Calculation from test by W. A. Bone, Dellwik-Fleischer system	53 p.ct.
3a.	Calculation from test by W. A Bone, Kramers and Aarts	59 p.ct.
5a.	Calculation from deductions by Strache and Jahoda .	56 p.ct.

No results of complete tests—including measurements of the power required for raising steam and driving the blower—on the production of blue water gas under ordinary working conditions in plant specially designed for blue gas, appear to have been published. The value and importance of the tests described in detail in this report will therefore be at once apparent.

* See "JOURNAL," Vols. LXXVII., pp. 27, 87, 145, 208, 275, 401; and LXXXVIII., p. 771.

BLUE WATER-GAS INSTALLATION AT ADDERLEY STREET, BIRMINGHAM.

The general arrangement of the blue water-gas installation at the Adderley Street works is shown in plan in Diagram I. The generator-house and blower-house are situated on the right bank of the Birmingham and Warwick canal, which runs through the middle of the works. The plant enclosed in the generator-house and blower-house was erected during 1917 by Messrs. Humphreys and Glasgow, Ltd. Gas making was commenced early in 1918.

Generator.—The generator, shown in horizontal and vertical sections in Diagram II., consists of a cylindrical steel shell lined with firebrick blocks, which are separated from the metal by annular spaces packed with non-conducting material. The bed of fuel (about 7 ft. in thickness) rests on a flat bar grate on a level with which are clinkering doors, and below which is a door for removing the ashes into the pit immediately beneath. The generator is connected by pipes both above and below the fuel bed with the bottom of the scrubber. During the blow periods, the air enters at the bottom of the generator, and the blast products travel through the outlet-pipe at the top into the stack, which is controlled by a special valve. During the run periods, when the blast-valve is closed, the steam enters either below or above the fuel bed, and the resultant water gas is carried away to the scrubber by the outlet-pipe at the top or bottom, according to whether the steaming is being operated in an upward or downward direction. A special catch-pocket is so placed on the top outlet-pipe that it collects the heavier particles of coke carried forward during the blow period. The generator is charged with coke from metal hopper-barrows through the door in the extreme top. The plant is manipulated from an elevated operating floor flush with the generator charging door, at which level all levers controlling the necessary valves are assembled. A battery of gauges, indicating at any stage of the process the pressures in the air duct at the bottom of the generator, the generator base, generator top, and the outlet of the scrubber, enables the operator to judge the working conditions throughout the apparatus. Steam-meters, the indicator dials of which are also situated above the operating floor, enable the operator to regulate the steam-valves to obtain the desired rate of flow of steam. An interlocking valve gear prevents the operation of the steam and blast valves except in their safe and proper order.

Air to generator.—The air is supplied to the generator by means of a Sturtevant blower driven by a 20 H.P. De Laval turbine of the non-condensing type.

Steam to generator.—The steam is obtained from the main works supply from two Babcock and Wilcox water-tube boilers without superheaters.

Scrubber.—From the generator, the water gas made during the run periods passes into the bottom of the scrubber through a water-seal of 2½ in. The seal prevents the gas from being pushed back during the blow periods by the pressure thrown by the

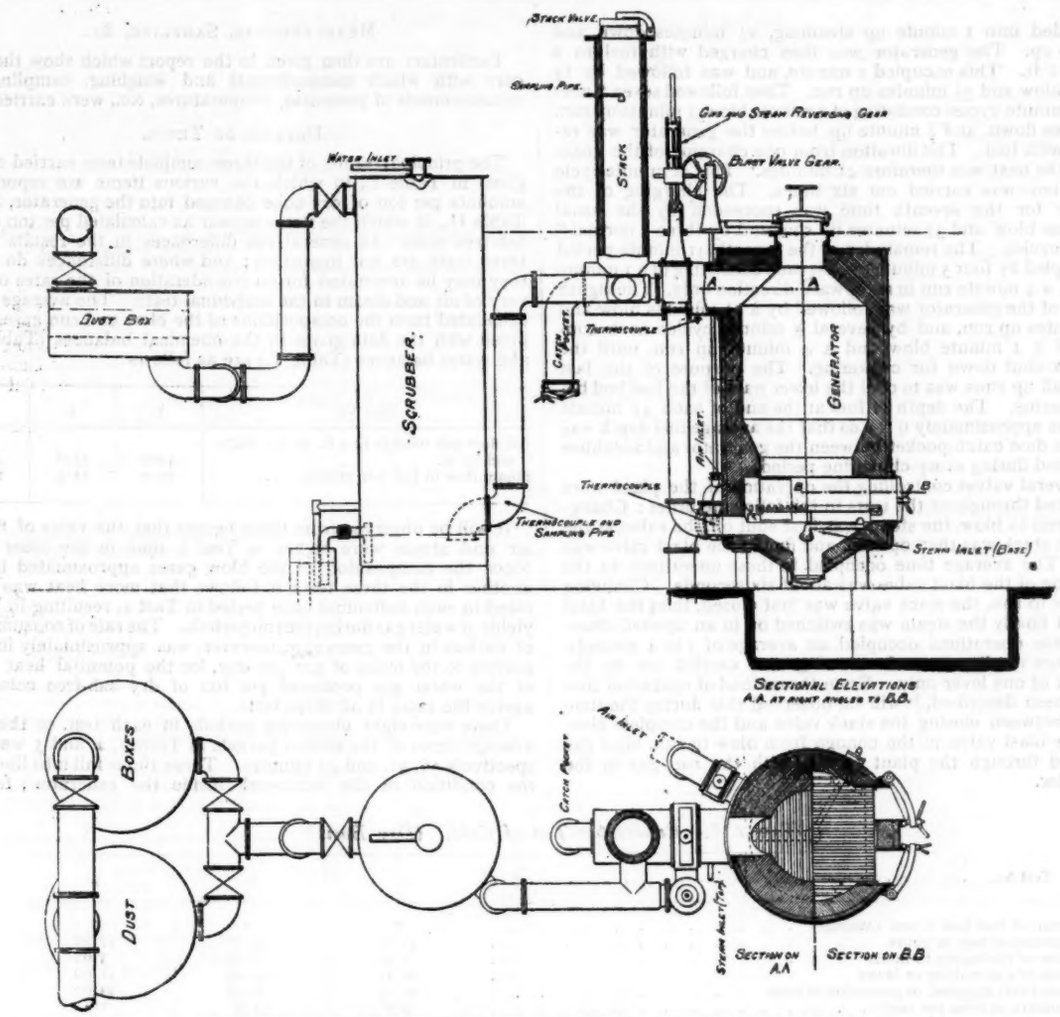


DIAGRAM II.—WATER-GAS PLANT, ADDERLEY STREET, BIRMINGHAM.

relief holder. The large area of the scrubber compared with the area of the dip-pipe enables this safety device to act at back-pressures very much higher than the actual amount of seal in operation during the run periods. The scrubber itself consists of a cylindrical steel shell packed with circular wooden grids similar in design to those ordinarily used in oxide purifiers, and which rest on a perforated steel plate. A rapid stream of cold water enters the scrubber at the top, is distributed by means of the wooden grids, and flows out through the overflow-pipes at the bottom into a separate seal. The purpose of the scrubber is to remove particles of tarry and solid matter, and at the same time to condense undecomposed steam and cool the water gas to atmospheric temperature.

Water to Scrubber.—The scrubber is supplied with canal water, usually at a rate of about 1500 gallons per hour, by means of two reciprocating pumps (one of which acts as a spare), situated in the blower house. The water is pumped from about 2 ft. below the surface of the canal through a 4 in. pipe, the end of which is covered with a perforated grid to remove the larger particles of solid matter.

Dust Boxes.—After leaving the top of the scrubber, the water gas is made to pass in parallel through two cylindrical steel dust boxes each containing special material. These boxes, which are additional to the usual apparatus, were erected in November last, and are at present being used in experiments devised with the object of removing a very troublesome dust which is carried forward and deposited in all sections of the plant, even beyond the relief holder. This problem is referred to again at the end of this section of the report.

Relief Holder.—From the two dust boxes the gas passes by way of a 12-in. main through the cellar of the horizontal retort house, then underground, through the valve in the holder well to the relief holder, which consists of two column-guided lifts. The top lift has a total capacity of approximately 110,000 c.ft. The second lift was not in operation during the period of the investigation.

Meter.—From the relief holder, the gas travels through a 12-in. main underground to a Thorpe's patent rotary meter of a maximum capacity of 50,000 c.ft. per hour; thence through a diaphragm governor to the inlet exhauster main of the coal-gas plant. The meter is preceded by a cylindrical iron box containing material to remove the dust already referred to under "Dust Boxes."

METHOD OF CONDUCTING TESTS.

The main object of the investigation was to ascertain the efficiency of the process of manufacture of blue water gas as ordinarily practised when reasonable care is exercised in controlling the conditions, and not to determine the maximum efficiency which may be obtained over a short period only. A considerable amount of preliminary work was therefore carried out to determine the average working conditions usually obtaining on the particular installation, quite apart from other necessary preliminary work, such as the calibration of the relief holder, rotary meter, steam nozzles, turbine and blower, flow of water through the scrubber, &c. The calibration of the rotary meter alone involved an extensive experimental inquiry, owing to the fact that it is measuring a gas carrying dust in an extremely finely divided condition. This dust gradually deposits in the tubes and on the vanes of the rotary meter, thereby causing a progressive increase in the speed of the meter for a constant rate of flow of gas. This matter is dealt with in detail in Section III., to which attention is specially directed.

When the normal working conditions of the plant had been ascertained, measured trials were run, each over a period of two full days. These trials, the results of which are reported under the headings Tests 1, 2, and 3, were carried out at intervals of two to three months. The generator was re-lined immediately after the first and immediately before the third test, so that the average of the three tests should represent a true working average. During the intervening periods, special investigations into the nature of the changes in reaction occurring during the individual run and blow periods, and throughout the complete cycle of operations from one clinker period to the next, were conducted. The methods of sampling were also examined. This was most essential, since in an intermittent process such as that adopted in the manufacture of water gas, it is no simple matter to ensure methods yielding true average samples.

PLANT ROUTINE.

Throughout the tests described in this report, the usual routine for the particular installation was adopted. Clinkering was carried out every six hours, and occupied about 50 minutes; the actual time varying with the nature and amount of the ash contained in the coke used and the state of the generator lining. Immediately after clinkering, the fuel bed was subjected to a "normal" 5 minute cycle consisting of a 1 minute blow and a 4 minute

run divided into 1 minute up steaming, 2½ minutes down, and ½ minute up. The generator was then charged with fuel to a depth of 8 ft. This occupied 1 minute, and was followed by 1½ minutes blow and 3½ minutes up run. Then followed seven "normal" 5 minute cycles consisting of 1 minute blow, 1 minute up run, 2½ minutes down, and ½ minute up, before the generator was recharged with fuel. The duration from one charging of the generator to the next was therefore 41 minutes. This 41 minute cycle of operations was carried out six times. The charging of the generator for the seventh time was succeeded by the usual 1½ minutes blow and 3½ minutes up run, and by three "normal" 5 minute cycles. The remainder of the seventh 41 minute period was occupied by four 5 minute cycles, each consisting of a 1 minute blow and a 4 minute run in an upward direction only. The eighth charging of the generator was followed by a 1½ minutes blow and a 3½ minutes up run, and by several 5 minute cycles each consisting of a 1 minute blow and a 4 minute up run, until the plant was shut down for clinkering. The purpose of the last series of all up runs was to cool the lower part of the fuel bed before clinkering. The depth of fuel at the end of each 41 minute period was approximately 6 ft; so that the average fuel depth was 7 ft. The dust catch-pocket between the generator and scrubber was emptied during every clinkering period.

The several valves controlling the operation of the plant were manipulated throughout the tests in the following order: Changing from run to blow, the steam was first shut off, the valve at the top of the stack was then opened, and finally the blast valve was opened. The average time occupied in these operations to the full opening of the blast valve was about six seconds. Changing from blow to run, the stack valve was first closed, then the blast valve, and finally the steam was switched on in an upward direction. These operations occupied an average of 3 to 4 seconds. The change of direction of steaming was carried out by the movement of one lever only. From the method of operation that has just been described, it will be observed that during the time occupied between closing the stack valve and the complete closing of the blast valve in the change from blow to run, blow gas was forced through the plant to mix with the run gas in the relief holder.

Measurements, Sampling, &c.

Particulars are then given in the report which show the great care with which measurements and weighing, sampling, and measurements of pressures, temperatures, &c., were carried out.

Details of Tests.

The principal results of the three complete tests carried out are given in Table I., in which the various items are reported in amounts per ton of dry coke charged into the generator, and in Table II., in which the items appear as calculated per ton of dry ash-free coke. In general, the differences in the results of the three tests are not important; and where differences do occur, they may be accounted for on consideration of the rates of delivery of air and steam in the individual tests. The average rates, calculated from the compositions of the blow and run gases combined with the data given in the chemical balances (Table VI.) and water balances (Table V.) are as follows:

Test No.	1.	2.	3.
Air flow per minute in c.ft. at 60° Fahr. and 30 in.	4260	5178	4633
Steam flow in lbs. per minute	20·2	21·5	20·8

It will be observed from these figures that the rates of flow of air and steam were higher in Test 2 than in the other tests. Since the composition of the blow gases approximated to one another in the three tests, it follows that more heat was generated in each individual blow period in Test 2, resulting in larger yields of water gas during the run periods. The rate of consumption of carbon in the generator, however, was approximately in proportion to the make of gas per day, for the potential heat value of the water gas produced per ton of dry ash-free coke was nearly the same in all three tests.

There were eight clinkering periods in each test, so that the average times of the clinker periods in Tests 1, 2, and 3 were respectively 56, 51, and 44 minutes. These times fall into line with the condition of the brickwork inside the generator; for, as

Table I.—*Results per Ton of Coke.* (*Dry Basis.*)

Test No.	1.	2.	3.
Depth of fuel bed in feet (average)	7	7	7
Duration of test in hours	47·65	47·78	47·82
Time of clinkering in hours	7·53	6·85	5·92
Time of gas-making in hours	40·12	40·93	41·90
Coke (wet) supplied to generator in tons	21·77	26·75	23·07
Moisture in coke per cent.	4·7	11·9	7·4
Coke (dry) supplied to generator in tons	20·75	23·57	21·36
Total gas (purified) made in cubic feet (60° Fahr. and 30 in.)	1,069,524	1,205,540	1,092,419
Gas in cubic feet per ton of coke to generator	51,543	51,147	51,143
Coke in lbs. to generator per 1000 c.ft.	43·46	43·80	43·80
Gas in cubic feet made per day	538,690	605,545	548,265
Gas in cubic feet made per hour of gas making	26,658	29,454	26,072
Composition of gas—volume per cent.: CO_2	4·00	3·80	4·95
C_mH_n	0·05	0·05	0·05
O_2	0·10	0·05	0·10
CO	42·20	42·35	39·60
H_2	48·10	49·60	49·80
CH_4	0·35	0·65	1·30
N_2	5·20	3·50	4·20
	100·00	100·00	100·00
Inerts, including oxygen	9·30	7·35	9·25
Specific gravity of gas (air = 1)	0·55	0·55	0·55
Calorific value of gas in B.Th.U. per cubic foot gross	293	305	306
" " " " " " " " " net	270	279	280
Thermal value of gas in therms gross per ton coke	151·0	156·0	156·5
" " " " " net " "	139·2	142·6	143·2
Thermal value of gas made per day in therms gross	1578	1847	1678
" " " " " " " " net	1454	1690	1535
Steam to generator in tons per ton of coke	0·766	0·734	0 804
" turbine " " " "	0·812	0·792	0·883
Fuel in therms per ton coke to raise steam for generator (70 p.ct. boiler efficiency)	27·3	26·2	28·7
Fuel in therms per ton coke to raise steam for turbine (70 p.ct. boiler efficiency)	29·0	28·3	31·5
Total fuel in therms per ton coke for raising steam	56·3	54·5	60·2
Sulphuretted hydrogen in grains per 100 c.ft. in gas at inlet scrubber	267	290	305
" " " " volume per cent. " " " "	0·43	0·46	0·49
Ammonia in grains per 100 c.ft. in gas at inlet scrubber	2·62	2·62	2·62
Sodium ferrocyanide (crystallized) in lbs. per ton coke—equivalent of cyanogen in gas at inlet scrubber	0·42	0·42	0·42
Naphthalene in grains per 100 c.ft. in gas at inlet scrubber	0·57	0·57	0·57
Sulphur in grains per 100 c.ft. in purified gas	22·3	22·3	22·3
Composition of blow gas—volume per cent.: CO_2	12·3	11·9	12·3
O_2	0·2	0·2	0·2
CO	12·6	12·8	12·9
H_2	3·0	3·0	2·9
CH_4	0·5	0·4	0·6
N_2	71·4	71·7	71·1
	100·00	100·00	100·00
Calorific value of blow gas in B.Th.U. per cubic foot gross (calculated)	55	54	56
" " " " " " " " net "	53	52	54
Sulphur dioxide calculated as grains sulphur per 100 c.ft. blow gas	38·5	38·5	38·5
Dry ashes withdrawn in tons per ton coke	0·133	0·139	0·118
Dry clinker " " " " "	0·064	0·036	0·048
Dust from pocket in tons per ton coke	0·016	0·011	0·008

TABLE II.—*Results per Ton of Coke (Dry, Ash-Free).*

Test No.	1.	2.	3.
Coke supplied to generator in tons	17·58	20·95	18·62
Gas in cubic feet per ton coke to generator	60,838	57,544	58,669
Coke in lbs. to generator per 1000 c.ft.	36·81	38·92	38·18
Thermal value of gas in therms gross per ton coke	178·2	175·5	179·5
,, ,, ,, ,, net ,, ,,	164·3	160·5	164·3
Steam to generator in tons per ton coke	0·904	0·826	0·922
,, turbine ,, ,, ,,	0·959	0·891	1·013
Fuel in therms per ton coke to generator to raise steam for generator (70 p.ct. boiler efficiency)	32·3	29·5	32·9
Fuel in therms per ton coke to generator to raise steam for turbine (70 p.ct. efficiency)	34·2	31·8	36·2
Total fuel in therms per ton coke for raising steam	66·5	61·3	69·1
Ash-free material in tons withdrawn per ton coke from generator and dust pocket	0·079	0·086	0·059

TABLE III.—*Pressures, Temperatures, &c., on Plant.*

Test No.	1.				2.				3.			
	Blow.	Run.			Blow.	Run.			Blow.	Run.		
Pressures in inches of water—												
Air duct, outlet blower	16·5	20·5			16	22			15·2	22·5		
	↑	↑	↓	↑	↑	↑	↓	↑	↑	↑	↓	↑
Generator base	13·5	23	16·5	15	14·5	25	20	17	13	23·5	16	14
,, top	2	23	17	15	3·5	25	20·5	17	2·25	23·5	16·5	14
Scrubber outlet	3·25	15	10	8	3·25	15·5	11·5	9·5	3·25	15	8·5	7
Steam pressure at nozzles in lbs. per sq. in.		36·4	43·0	36·4		41·0	44·0	41·0		41·0	42·0	41·0
Steam delivered in lbs. per minute—												
Calculated from steam pressure at nozzles		19·6	19·8	19·6		21·2	20·1	21·2		21·2	19·4	21·2
,, from undecomposed steam and composition of water gas		20·2				21·5				20·8		
Steam pressure to turbine in lbs. per sq. in.	53·7	38·7			61·0	43·0			51·0	44·5		
Temperatures in degrees Centigrade—												
Water gas, outlet generator		365				365				365		
,, ,, inlet scrubber		270				270				270		
,, ,, outlet ,,		22				14				10		
Air, inlet generator		38				28				23		
,, ,, blower		32				22				17		
Blow gas, outlet generator		330				330				330		
,, ,, sample pipe in stack		265				265				265		
Water, inlet scrubber		19				10				7		
,, outlet ,,		41				27				28		

previously stated, the lining was renewed immediately after the first test and immediately before the third.

The average water gas made in each of the three tests contained less than 5 p.ct. carbon dioxide, more than 39·5 p.ct. carbon monoxide, and more than 48 p.ct. hydrogen. The considerable differences in the methane contents may be due to differences in the temperatures of the fuel bed, the catalytic effects of ash, the nature and amounts of volatile matter in the coke, and other causes.

There were no large differences in the average compositions of the blow gases, which contained 11·9 to 12·3 p.ct. carbon dioxide, 12·6 to 12·9 p.ct. carbon monoxide, 3·0 p.ct. hydrogen, and about 0·5 p.ct. methane. A certain amount of the hydrogen contained in the blow gases was undoubtedly due to the water gas swept forward from the generator during the first few seconds of each blow period. The gross and net calorific values of the blow gases have been calculated from the following data given in Coste's "Calorific Power of Gas," p. 66.

B.Th.U. per Cubic Foot at 60° Fahr. and 30 In. Moist.	Methane.	Hydrogen.	Carbon Monoxide.
Gross	992	320	318
Net	890	269	318

The figures quoted for the amounts of ammonia, cyanogen, and naphthalene in the gas at the scrubber inlet, and for the amounts of sulphur in the purified gas and sulphur dioxide in the blow gas, are the averages of a number of experiments carried out both during the tests and the intervening periods. The ammonia content of the gas at the scrubber inlet was small; being equivalent to only about 0·75 lb. of ammonium sulphate per ton of coke charged into the generator. The average of the determinations of the crystalline sodium ferrocyanide equivalent of the cyanogen in the water gas was found to be 0·42 lb. per ton of coke to the generator, or about 0·08 lb. per 10,000 c.ft. of gas made.

The amounts of fuel in therms required to raise the steam for the generator and for driving the blower have been calculated on the basis of a 70 p.ct. boiler efficiency, which efficiency value was adopted in similar calculations in the fourth report on steaming in continuous vertical retorts at Uddingston.

The averages of the temperatures and pressures at different positions in the plant, recorded during the tests, appear in Table III. The actual pressures at the generator base and generator top during the run periods gradually decreased from the beginning to the end of each run, owing to the reduction in the rate of production of water gas resulting from the falling temperature of the fuel bed, and the consequent lower percentages of steam decomposed. The pressures in the air duct during the blow periods gradually rose from one clinker period to the next, owing to the progressive increase in the resistance of the fuel bed resulting from the accumulation of clinker in the generator. The average pressures in the air duct during the blow periods do not necessarily bear a simple relation to the rates of air flow, since these pressures would be dependent, not only on the resistance of the fuel bed, but also on the speed of the blower. The pressure at the scrubber outlet during the blow period was that thrown by the relief holder.

The average rates of flow of steam to the generator in pounds per minute during the up and during the down runs have been calculated from the pressures of steam at the nozzles and the respective throat areas; but the average rates of flow throughout each test have been calculated from the compositions of the water gas made and the amounts of decomposed steam, since it is considered this latter method yields more reliable results.

The comparatively low temperatures of the blow and run gases at the outlets of the generator are worthy of notice. The temperatures recorded, however, are in good agreement with similar readings taken by Strache and Jahoda ["JOURNAL OF GAS LIGHTING," 1901] in their extensive research on this subject. Comparing the temperature of the blow gases at the position of sampling in the stack with the temperature at the outlet of the generator, it is to be observed that a temperature drop of about 65° C. occurred over the short distance travelled. In their passage from the generator outlet to the scrubber inlet, the run gases cooled from 365° to 270° C. The temperature of the air at the inlet generator in each test was a few degrees higher than when admitted to the blower. The differences between the air temperatures recorded in the three tests were due mainly to differences in atmospheric conditions. This point is also brought out in the temperature readings of the water into the scrubber.

The results of analyses and determinations of the calorific values of dried samples of the coke used in the generator, and of the ashes, clinker, and dust withdrawn during the three tests, are given in Table IV. The amounts of ash in the coke were more or less normal for coke as obtained at the present time.

TABLE IV.—*Analyses of Coke, Ashes, Clinker, and Dust (Dry Samples).*

Test No.	1.	2.	3.
COKE:			
Proximate analysis:			
Volatile matter	4·2	4·2	4·3
Fixed carbon	80·5	84·7	82·9
Ash	15·3	11·1	12·8
	100·0	100·0	100·0
Ultimate analysis:			
Ash	15·3	11·1	12·8
Carbon	80·1	84·1	82·9
Hydrogen	1·0	0·9	0·8
Sulphur	2·0	1·9	1·9
Nitrogen	1·6	2·0	1·6
Oxygen	0·0	0·0	0·0
	100·0	100·0	100·0
Calorific value (gross) in B.Th.U. per lb. (determined)	12,182	12,456	12,352
ASHES:			
Ultimate analysis:			
Ash	64·1	52·8	65·4
Carbon	34·0	44·5	33·0
Hydrogen	0·2	0·2	0·1
Sulphur	1·2	1·5	0·9
Nitrogen	0·5	1·6	0·6
Oxygen	0·0	0·0	0·0
	100·0	100·0	100·0
Calorific value (gross) in B.Th.U. per lb. (calculated)	5,119	6,658	4,900
CLINKER:			
Ultimate analysis:			
Ash	90·9	95·3	91·5
Carbon	7·2	3·9	7·3
Hydrogen	0·1	0·0	0·1
Sulphur	1·7	0·7	1·0
Nitrogen	0·1	0·1	0·1
Oxygen	0·0	0·0	0·0
	100·0	100·0	100·0
Calorific value (gross) in B.Th.U. per lb. (calculated)	1,177	596	1,165
DUST:			
Ultimate analysis:			
Ash	18·3	15·3	19·3
Carbon	77·7	80·8	77·0
Hydrogen	0·6	0·6	0·4
Sulphur	2·0	1·7	1·8
Nitrogen	1·4	1·6	1·5
Oxygen	0·0	0·0	0·0
	100·0	100·0	100·0
Calorific value (gross) in B.Th.U. per lb. (determined)	11,839	12,146	11,405

WATER BALANCES.

Water balances showing the amounts of steam used in the various operations in the manufacture of water gas during the three tests are given in Table V.

TABLE V.—*Pounds of Steam per* 1000 *C.Ft. of Water Gas.*

Test No.	1.	2.	3.
Water equivalent of water gas	22·91	23·89	24·60
Water vapour accompanying water gas	10·39	8·28	10·60
Total steam supplied to generator	33·30	32·17	35·20
Steam supplied to turbine	35·31	34·69	38·67
Total steam used	68·61	66·86	73·87
Steam to generator decomposed, per cent.	68·8	74·3	69·9

For the purposes of constructing these balances, the water equivalent of the water gas made was calculated from the composition of the gas as given in Table I.; and the water vapour accompanying the water gas—*i.e.*, the amount of undecomposed steam—is the result of direct determination on the gas at the inlet to the scrubber. The sum of these two items represents the total amount of steam supplied to the generator, which amount is in good agreement with that calculated from the pressures of steam at the inlets to the nozzles of the meters according to the method described under the heading "Calculation of the Steam Supply to Generator" in Section III. The amounts of steam supplied to the turbine were calculated from the recorded pressures of steam on the nozzles of the turbine. The percentages of steam decomposed, which average 71 p.ct., were obtained from the ratios of the steam converted into water gas and the total steam supplied to the generator. The total amount of steam required for the generator and for driving the blower throughout the tests averaged 69·8 lbs. per 1000 c.ft. of water gas made.

TEMPERATURES FROM COMPOSITIONS OF WATER GAS.

The temperatures corresponding with the relative amounts of carbon dioxide, carbon monoxide, and hydrogen in the water gas made, and with the percentages of steam decomposed during each of the three tests, have been read off from curves in Diagram III., constructed from the results obtained by Harries ["Journal für Gasbeleuchtung," 1894, p. 81] on passing steam over carbon at different temperatures. Three of the curves represent the amounts of carbon dioxide, carbon monoxide, and hydrogen as percentages of the total volume of these gases; and the fourth curve represents the percentages of steam decomposed at different temperatures. From the figures obtained, it may be concluded that the compositions of the water gas made in the three tests correspond with an approximate temperature of 975° C., compared with 960°, 957°, 926°, and 920° C. in the steaming tests Nos. 2, 3, 4, and 5 respectively carried out at Uddingston. But the conclusion is only of a tentative nature, since the results of experiments of the type carried out by Harries are dependent largely on the conditions. It should be noted that the figures given by L. J. Willien,* and quoted in the fourth report of the Gas Investigation Committee, were taken from the results of Harries' experiments.

DISTRIBUTION OF CARBON, NITROGEN, AND SULPHUR.

Chemical balances for carbon, nitrogen, and sulphur have been drawn up from the results of analyses for the amounts of these elements in the coke supplied to the generator, the water gas made, the blow gas produced, and in the ashes, clinker, and dust withdrawn. These balances are set out in Table VI., in which the

TABLE VI.—*Chemical Balances Calculated in Lbs. per* 1000 *C.Ft. Gas Made.*

Test No.	1		2		3	
Carbon Balance:						
Coke		34·81		36·84		36·31
Water gas	14·57		14·65		14·35	
Ashes	1·97		2·71		1·71	
Clinker	0·20		0·06		0·15	
Dust	0·54		0·39		0·27	
Blow gas (differ.)	17·53		19·03		19·83	
		34·81		36·84		36·31
Nitrogen Balance:						
Coke		0·695		0·876		0 701
Ashes	0·029		0·061		0·031	
Clinker	0·003		0·002		0·002	
Dust	0·010		0·008		0·005	
Ammonia in gas	0·003		0·003		0·003	
Cyanide in gas	0·001		0·001		0·001	
N_2 in water gas and blow gas (differ.)	0·649		0·801		0·659	
		0·695		0·876		0·701
Sulphur Balance:						
Coke		0·869		0·832		0·832
Water gas	0·391		0·422		0·442	
Ashes	0·069		0·091		0·047	
Clinker	0·047		0·011		0·021	
Dust	0·014		0·008		0·006	
Blow gas	0·122		0·134		0·136	
Difference	0·226		0·166		0·180	
		0·869		0·832		0·832

figures given represent the weights of these elements in lbs. per 1000 c.ft. of water gas made. In the carbon balances, the amounts of carbon in the blow gas produced have been taken as

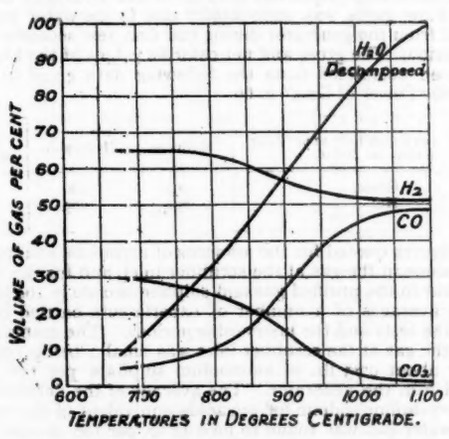


Diagram III.—Steam-Carbon Reactions (Bunte and Harries).

the differences between the weights in the coke supplied to the generator and the total of the weights accounted for in the other items. This method of calculation of the carbon in the blow gas is not strictly accurate, since it includes a certain amount of

* See "JOURNAL," Vol. CXLVI., p. 97.

solid carbon which was always carried forward up the stack. But it appeared to be the only method of calculation available; and, in any case, the results obtained should be sufficiently accurate for the purpose of the tests.

TABLE VII.—*Distribution of Carbon, Nitrogen, and Sulphur.*

Test No.	1.	2.	3.
Carbon:			
Coke	100·00	100·00	100·00
Water gas	41·86	39·78	39·53
Ashes	5·66	7·36	4·71
Clinker	0·57	0·16	0·41
Dust	1·55	1·06	0·74
Blow gas (differ.)	50·36	51·64	54·61
	100·00	100·00	100·00
Nitrogen:			
Coke	100·0	100·0	100·0
Ashes	4·2	7·0	4·4
Clinker	0·4	0·2	0·3
Dust	1·4	0·9	0·7
Ammonia in gas	0·4	0·3	0·4
Cyanide in gas	0·1	0·1	0·1
N_2 in water gas and blow gas (differ.)	93·5	91·5	94·1
	100·0	100·0	100·0
Sulphur:			
Coke	100·0	100·0	100·0
Water gas	45·0	50·7	53·1
Ashes	7·9	10·9	5·6
Clinker	5·4	1·3	2·5
Dust	1·6	1·0	0·7
Blow gas	14·0	16·1	16·4
Difference	26·1	20·0	21·7
	100·0	100·0	100·0

In Table VII. the figures have been brought up in such proportions that the amount of each element in the coke supplied to the generator is represented as 100. The items in Table VII., therefore, show the distribution of carbon, nitrogen, and sulphur as percentages of the amounts present in the original coke. It will be observed from a survey of the tables that approximately 40 p.ct. of the carbon of the coke appeared in the water gas, 52 p.ct. in the blow gas, and the rest in the ashes, clinker, and dust. The bulk of the nitrogen (over 90 p.ct.) was converted into "free" gas, which would be carried away with the water gas and blow gas. The amounts given against the difference item in the sulphur balances are not entirely due to working losses and experimental errors, for considerable proportions of free sulphur were found in the dust carried through the scrubber and deposited in the plant beyond this point; and certain amounts of free sulphur were carried away by the water flowing through the scrubber. The amounts of sulphur accounted for in the blow gas have been calculated from the proportion of this element, as determined by experiment, combined with the volumes of blow gas calculated from the weights of carbon consumed (carbon balance) during the blow periods, and the compositions of the gas passing up the stack (Table I.). The volumes of blow gas per 1000 c.ft. of water gas made as calculated by this method were 2213 c.ft., 2432 c.ft., and 2465 c.ft. respectively in the three tests.

HEAT BALANCES AND THERMAL EFFICIENCIES OF GAS PRODUCTION.

The heat balances of the process of production of water gas as adopted in the tests are set out in Table VIII., in which the different items are given in therms per 1000 c.ft. of water gas made. Four sources of heat in the complete process are considered:

(*a*) Heat supplied as fuel to the generator.
(*b*) Fuel required to raise steam for the generator calculated on the basis of a 70 p.ct. boiler efficiency.
(*c*) Fuel required to raise steam for the turbine calculated on the basis of a 70 p.ct. boiler efficiency.
(*d*) Sensible heat of the air supplied to the blower.

The expenditure of the total heat in the four items is accounted for in thirteen items:

(1) Potential heat of water gas calculated from the gross calorific values in Table I.
(2) Sensible heat of water gas at generator outlet.
(3) Total heat of undecomposed steam at generator outlet—*i.e.*, sensible heat *plus* latent heat.
(4) Potential heat of blow gas calculated from gross calorific values. [Table I.]
(5) Sensible heat of blow gas at generator outlet. This item includes the total heat of the water vapour resulting from the evaporation of moisture in the coke charged into the generator.
(6) Heat lost in raising steam for the generator. These figures are 30 p.ct. of the figures in item (*b*).
(7) Heat lost in raising steam for the turbine. These figures are 30 p.ct. of the figures in item (*c*).
(8) Heat of the steam used and lost in the turbine and blower. This figure is obtained by deducting the heat added to the air as a result of compression in the blower from the total heat of the steam supplied to the turbine. The sum of items (7), (8), and the heat added to the air by compression, is identical with item (*c*).

TABLE VIII.—*Heat Balances in Therms per 1000 C.Ft. Water Gas Made.*

One therm = 100,000 B.Th.U.

Heat to raise steam = Amount from 60° Fahr. (with 70 p.ct. efficiency) = $1116 \times \frac{100}{70}$ B.Th.U. per lb.

Test No.	1.	2.	3.
Heat supplied:			
(*a*) Coke to generator	5·294	5·456	5·410
(*b*) Fuel to raise steam to generator	0·531	0·513	0·561
(*c*) ,, ,, ,, turbine	0·563	0·553	0·617
(*d*) Sensible heat of air to blower	0·010	0·005	0·001
	6·398	6·527	6·589
Accounted for as follows:			
1. Water gas, potential heat	2·930	3·050	3·060
2. ,, ,, sensible heat	0·118	0·118	0·119
3. Steam not decomposed (total heat)	0·143	0·114	0·146
4. Blow gas, potential heat	1·217	1·313	1·380
5. ,, ,, sensible heat	0·267	0·340	0·312
6. Heat lost in raising steam to generator	0·159	0·154	0·168
7. ,, ,, ,, ,, turbine	0·169	0·166	0·185
8. Heat of steam used and lost in turbine and blower	0·390	0·383	0·428
9. Ashes, potential heat	0·296	0·405	0·253
10. Clinker ,, ,,	0 033	0·009	0·024
11. Dust ,, ,,	0·082	0·059	0·040
12. Ashes, clinker and dust, sensible heat	0·027	0·023	0·022
13. Losses not separately determined, leakages, radiation, convection, &c. (difference)	0 567	0·393	0·452
	6·398	6·527	6 589

TABLE IX.—*Heat Balances per Cent.*

Heat Value of Total Fuel to Generator and for raising Steam = 100.

Test No.	1.	2.	3.
Heat supplied:			
(*a*) Coke to generator	82·74	83·59	82·11
(*b*) Fuel to raise steam to generator	8·30	7·86	8·51
(*c*) ,, ,, ,, ,, turbine	8·80	8·47	9·36
(*d*) Sensible heat of air to blower	0·16	0·08	0·02
	100·00	100·00	100·00
Accounted for as follows:			
1. Water gas, potential heat	45·80	46·73	46·44
2. ,, ,, sensible heat	1·84	1·81	1·81
3. Steam not decomposed (total heat)	2·23	1·74	2·21
4. Blow gas, potential heat	19·02	20·11	20·94
5. ,, ,, sensible heat	4·17	5·21	4·74
6. Heat lost in raising steam to generator	2·49	2·36	2·55
7. ,, ,, ,, ,, ,, turbine	2·64	2·54	2·81
8. Heat of steam used and lost in turbine and blower	6·09	5·87	6·50
9. Ashes, potential heat	4·63	6·21	3·84
10. Clinker, ,, ,,	0·52	0·14	0·36
11. Dust, ,, ,,	1·28	0·90	0·61
12. Ashes, clinker and dust, sensible heat	0·42	0·35	0·33
13. Losses not separately determined; leakages, radiation, convection, &c. (difference)	8·87	6·03	6·86
	100·00	100·00	100·00
Efficiency of gas production per cent.:			
Fuel for steam for generator and turbine taken into account	45·8	46·7	46·4
Fuel for steam for generator and turbine *not* taken into account	55·2	55·9	56·5

TABLE X.—*Results per 1000 C.Ft. of Water Gas Made.*

Test No.	1.	2.	3.
Coke (dry) in lbs. to generator	43·46	43·80	43·80
Coke (dry) in lbs. to raise steam (70 p.ct. efficiency)	8·98	8·56	9 54
Total coke (dry) in lbs. to generator and for raising steam	52·44	52·36	53·34
Carbon in lbs. in coke to generator	34·81	36·84	36·31
Carbon in lbs. in coke to raise steam (70 p.ct. efficiency)	7·19	7·20	7·91
Total carbon in lbs. to generator and for raising steam	42·00	44·04	44·22
Steam in lbs. to generator	33·30	32·17	35·20
Steam in lbs. to turbine	35·31	34·69	38·67
Total steam in lbs. to generator and turbine	68·61	66·86	73·87
Air supplied in cubic feet at 60° Fahr. and 30 in.	1995	2202	2214
Blow gas produced in cubic feet at 60° Fahr. and 30 in.	2213	2432	2465
Thermal value of water gas in therms (gross)	2·930	3·050	3·060
Thermal value of coke to generator in therms (gross)	5·294	5·456	5·410
Thermal value of coke to raise steam in therms (gross)	1·094	1·066	1·178
Thermal value of total coke	6·388	6·522	6·588
Efficiency of gas production per cent.—			
Fuel for steam for generator and turbine taken into account	45·8	46·7	46·4
Fuel for steam for generator and turbine *not* taken into account	55·2	55·9	56·5

(9), (10), and (11) Potential heats of ashes, clinker, and dust calculated from the calorific values in Table IV.

(12) Sensible heat of the ashes, clinker, and dust, on the assumption that they were withdrawn from the generator at 800° C.

(13) The balance, which includes losses not separately determined.

In the calculations of the various items, the same values of heat capacities were used as in the construction of similar balances from the results of the Uddingston tests. It should be noted that throughout the balances in Table VIII. the calorific values are taken at ordinary temperature (15·5° C.), and that the figures for amounts of sensible heat represent the differences of the heat contents at ordinary temperature and the temperature of the substance under consideration.

In the heat balances in Table IX. the value of the total amount of heat supplied is taken as 100, and the other figures are in proportion; so that the items appear as percentages of the total heat supplied to the generator and required to raise steam. The thermal efficiencies of gas production are represented by the figures against item (1), which are in good agreement with one another, and average 46·3 p.ct. When the fuel for raising steam is not taken into account, the thermal efficiencies of gas production average 55·9 p.ct. It is interesting to compare these results with the efficiencies of production of the extra gas made by steaming the charges in continuous vertical retorts at Uddingston [Fourth Report of Research Sub-Committee of the Institution]. Abnormally high efficiencies are obtained by calculation from the results of the Uddingston tests, unless the differences in the heat losses of carbonization are taken into account, since it so happened that these losses were greater in Test 1 without steam than in the steaming tests. After applying the necessary corrections for the differences in carbonization losses, the calculated thermal efficiencies of the extra gas resulting from steaming are 68·5 p.ct., 64·6 p.ct., 64·7 p.ct., and 57·6 p ct. in the Uddingston Tests 2, 3, 4, and 5 respectively. These efficiencies of production of water gas by steaming in continuous vertical retorts are all higher than those obtained in the three tests on the water-gas plant, even when no allowance is made for fuel for raising steam.

The balances in Table IX. indicate where the heat losses occurred in the water-gas tests, and consequently where possible economies might be effected. The greatest individual loss is represented by the potential heat of the blow gas, which accounts for approximately 20 p.ct. of the total heat supplied. The average amount of heat lost as sensible heat in the water gas, blow gas, and undecomposed steam—items (2), (3), and (5)—was approximately 8·6 p.ct. of the heat supplied.

The heat losses represented by items (2), (3), (4), and (5) might be reduced considerably by the installation of waste-heat boilers. Calculations have therefore been made of the heat available for use in a waste-heat boiler on the assumptions that (i.) the effluent water gas leaves the boiler at 300° C., (ii.) the potential heat of the blow gas is liberated by combustion with air in such proportion that the product gases contain 3·0 p.ct. oxygen, and (iii.) the products of combustion leave the boiler at 300° C. The results of the calculations show that, on these assumptions, the heat per 1000 c.ft. of water gas made available for use in a waste-heat boiler would raise approximately 69 lbs., 74 lbs., and 78 lbs. of steam respectively in the three tests, on the basis of a 70 p.ct. boiler efficiency. These amounts would be sufficient to provide the steam required for the generator, and to drive the blower. The average efficiency of production of water gas would then be 55·9 p.ct. If the potential and sensible heats of the blow gases alone were used in a waste-heat boiler, the amounts of steam raised would be approximately 67 lbs., 72 lbs., and 76 lbs. respectively in the three tests, or about 2 lbs. less than the figures already given. It should be noted that these calculations of the quantities of steam which could be raised in a waste-heat boiler only hold for the particular amounts and compositions of blow gas obtained under the conditions of the tests described in this report. The figures cannot be applied to any other conditions of operation of a water-gas generator.

It is interesting to compare the calculated higher thermal efficiency of the water-gas plant, resulting from the installation of a waste-heat boiler, with the efficiencies that may have been obtained from the introduction of a waste-heat boiler in the Uddingston tests. Calculations from these latter tests, on the assumption that the waste gases left the boiler at 300° C., show that, on the basis of a 70 p.ct. boiler efficiency, more steam would have been raised than was admitted to the retorts in Tests 2, 3, and 4, but that a boiler efficiency of 80 p.ct. would have been necessary to provide the whole of the steam admitted to the retorts in Test 5. The following over-all efficiencies of carbonization and gas production would have been obtained in the Uddingston tests on the assumption that sufficient waste heat was recovered to raise the steam for the retorts.

UDDINGSTON TESTS.

Thermal Efficiencies on the Assumption that the Steam Admitted to the Retorts was Raised by Waste-Heat Boiler.

Test No.	1 No Steam.	2	3	4
Efficiency of carbonization, per cent.	83·18	84·86	83·91	86·21
Efficiency of gas production, ,,	54·37	61·02	62·23	68·50

With the installation of a waste-heat boiler, the efficiencies of gas production in the Uddingston Tests 2, 3, and 4, in which steam was admitted to the retorts, would therefore have been higher than could be obtained on the water-gas plant operated according to the methods used in the three tests described in this report. But *it must be emphasized that these results are obtained by calculations based on several assumptions which are only approximate. Before reliable conclusions can be drawn regarding the advantages or disadvantages resulting from waste-heat boilers in continuous vertical retort-settings or blue water-gas plants, actual working tests are required.*

The thermal efficiency of the blue water-gas plant at Birmingham operated as described in this report is somewhat lower than has been found in some previous tests. This is no doubt partly accounted for by the fact that the conditions of operation were those of normal continuous working extended over a considerable period, which are necessarily less favourable than those of any short-period tests. Moreover, it has been shown by calculation that, in the tests at Birmingham, the blow gas contained sufficient heat to raise in waste-heat boilers the steam required for operation; but in some of the other tests quoted the heat of the blow gases would have been insufficient, so that it would have been necessary to raise additional steam independently. Assuming utilization of blow gases for steam raising in these various tests, the differences in efficiencies obtained would be appreciably reduced.

The largest single item of thermal loss, the potential heat of the blow gases, is due mainly to the presence of carbon monoxide in some quantity. If this had been further burned to carbon dioxide in the fuel bed, heat would have been stored more quickly, the time of blow shortened, and the heat loss in the blow gases lessened. An alternative method of diminishing the loss of heat due to the potential heat of the blow gases would therefore be to reduce the amount of carbon monoxide carried away up the stack, by lessening the depth of the fuel bed, or by other changes in the method of operation or design of the plant, in so far as such changes could be made without prejudice to the efficient production of water gas during the run periods. It should be noted that the blue water-gas plant differs from the carburetted water-gas plant in that, if no waste-heat boiler is used, the potential and sensible heat of the blow gases is wasted; whereas in the manufacture of carburetted water gas it serves to some extent a useful purpose in cracking the oil. If, for any reason, it is advisable to retain the conditions of working and design which give such considerable quantities of heat in the blow gases, the addition of a waste-heat boiler is evidently necessary in order to minimize this loss. What can be done in this direction has already been discussed, and is worthy of experimental investigation.

It is useful, when making comparisons of different types of water-gas generators, or when considering new designs of plant, to have approximate data for the make of gas per square foot of grate area, the time-contact of the gases in the fuel bed, &c. The following figures are therefore given as representing the approximate conditions which obtained in the tests carried out on the blue water-gas plant at Birmingham, which plant has a grate area of 23 sq. ft.

(i.) Average make of water gas per minute during run periods per sq. ft. of grate area = 25 c.ft. (measured at 60° Fahr. and 30 in.).

(ii.) Average amount of steam supplied per minute during run periods per sq. ft. of grate area = 0·9 lb.

(iii.) Average volume of air supplied per minute during blow periods per sq. ft. of grate area = 200 c.ft. (measured at 60° Fahr. and 30 in.).

(iv.) Average time of contact of the gases with the fuel in the generator during the run period = 2 to 2½ seconds. This time was calculated on the assumptions that the average temperature of the fuel bed was 800° C., and that the actual volume of the fuel was equal to the volume of the interspaces.

For convenience in reference, a number of the results obtained per 1000 c.ft. of gas made in the blue water-gas tests have been grouped together in Table X.

DEPOSIT IN WATER-GAS PLANT.

This report on the manufacture of blue water gas in the installation at Adderley Street, Birmingham, would not be complete without further reference to the considerable trouble caused by the deposition of a yellow-brown powder in a finely-divided condition in almost all sections of the plant beyond the scrubber. In the main at the outlet of the scrubber, the deposit was usually found as a wet paste, which could be removed by periodic flushing with water. Further along the main, as it passed through the cellar of the horizontal retort-house, the deposit was in a more dry condition. It could not then be entirely removed by flushing with water; so that every two or three months it was necessary to clean the main by means of scrapers. The greatest trouble resulted from the decomposition of the dust at the bends near the valves in the holder-well. The deposit has never been entirely removed from these bends, though it has been kept within reasonable limits by flushing the main with hot water during clinkering periods, two or three times each week. The reasons that the deposit could not be entirely removed seem to be that at these positions it consisted of very fine particles coated with oily

or tarry matter, which rendered wetting with water difficult; and, further, the supply of water for flushing was insufficient to ensure a rapid flow in the main itself. The fact that the dust passed through the scrubber and the relief holder points to the difficulties to be encountered in attempts to precipitate it completely at any convenient position.

A similar deposit was also formed in the tubes and on the vanes of the rotary meter, which consequently speeded-up gradually, until the readings were very much higher than the actual volumes of gas passed. It was therefore necessary to arrange that during the period of the work of the Research Committee, the meter should be out of circuit, except when the three tests were being carried out, or when it was decided to run the meter for other special purposes. The meter was carefully cleaned out and calibrated immediately before each test; and a further calibration was made as soon as the test had been completed. The final correction to be applied to the meter reading during each test was calculated from the results of the two calibrations. A large number of calibrations of the meter at different times, and the close agreement between the results of successive calibrations, have proved that, with the special precautions adopted, the correct gas volumes given in the tests can be relied upon to possess an accuracy certainly within 2 p.ct., and probably within 1 p.ct.

The following is typical of the results of analyses of samples of dust deposited in the meter:

Tarry and carbonaceous matter	11·3 p.ct.
Free sulphur	7·8 ,,
Silica	66·9 ,,
Oxides of iron and aluminium	2·5 ,,

This problem is at present under further investigation.

It is surprising that few references regarding this deposit have previously been made in the Technical Press; and those that have been made give very little information. The following statement appears in a paper "Notes on Deposits Taken from Manufacturing and Distributing Systems" by W. Buckley*:

> Mr. Thorp once sent me a sample from a rotary meter fixed at the outlet of the condenser on a carburetted water-gas plant. It was a gelatinous tarry mass, and examination showed it consisted of 91·2 p.ct. of tarry matter and 8·78 p.ct. of residue in the form of a perfectly white powder. This white powder contained 89·7 p.ct. of silica.

Reference to a similar deposit taken from the carburettor of a water-gas plant was also made last year in the report of the Commission on Manufacture to the Société Technique du Gaz. According to this report, the deposit contained 30 p.ct. of sulphur, 30 p.ct. of silica, and 30 p.ct. of oxide of iron.

(To be continued.)

* See "JOURNAL," Vol. CXXIX., p. 590.

Chemistry and Gas Engineering.

Addressing the Empire Gas and Electric Association on the importance of gas bye-products in connection with American industrial security, Mr. R. S. M'Bride said that the successful gas engineer is inevitably a chemical engineer of no mean ability. Whether or not he recognizes this fact is of secondary importance; for in his success as a gas operator he will have applied chemical control and observed the principles of chemical science. Otherwise he would not have succeeded. As a matter of fact, it is, perhaps, not too much to say that gas engineering is fundamentally chemical engineering. In other words, it is a part of that industrial profession in which should be blended all the science of chemistry and the best possible technology of the mechanical engineer. Indeed, without the best of each of these two professions, the maximum of success cannot be obtained in the control of the most complex industrial chemical operation that has thus far been successfully undertaken by any branch of science or technology. Because of their close professional relationship, the chemist and the gas engineer find much in common. In fact, their work together can properly become a most intimate co-operation; for both professionally and industrially each has much to offer the other. Without continued advances in chemistry, the art of gas making will not progress. Without the products which are derived during gas manufacture, the chemist is helpless in the industrial advancement of many fields in which he is recognized as chief. Moreover, without the chemical markets for his bye-products, the gas and coke-oven operator would rapidly drop back to the antiquated systems of a former century. Modern processes, demanding, as they do, tremendous investments relative to the value of the gas produced, are wholly uneconomic, unless supported to the very maximum of bye-product income.

The engineering conference of the Institution of Civil Engineers will open on Wednesday, June 29, with a welcome by the President (Mr. John A. Brodie) to delegates from the American Engineering Societies, who will thereafter convey a message of goodwill from American to British engineers, and will present the John Fritz Medal awarded to Sir Robert A. Hadfield, Bart. There will be a number of visits in connection with the conference; the places selected including the National Physical Laboratory and the Fuel Research Station at East Greenwich. The subjects of special interest to "JOURNAL" readers to be discussed are the "Utilization of Waste Heat in Gas-Works," to be introduced by Mr. E. G. Stewart, and "Desiderata in the Qualities of Town's Gas," by Dr. J. S. G. Thomas—on the Wednesday.

ELECTRICAL CLEANING OF GASES.

In a paper read before the Cleveland Section of the Association of Iron and Steel Electrical Engineers, Mr. N. H. Gellert discussed the adaptation of electrical cleaning to blast-furnace gases. He said that the electrical cleaning of gases, as developed several years ago by Dr. F. G. Cottrell, is a very simple process, making use of a few fundamental facts in physics. It is by means of what may be regarded as an electrical screen that blast-furnace gas may be cleaned of its dust and fume content to a degree finer than any mechanical screen can clean it without the considerable loss of back pressure. The gas is conducted through a vertical pipe, in the exact centre of which an electrode chain or wire is suspended. This electrode is charged with a high-tension unidirectional current. When the dirty gas passes through the pipe, and comes in contact with the charged electrode, it becomes ionized. The gas molecules carry the charge to the dust particles, which for the most part are negatively electrified. Immediately upon being charged, the dust and fume particles are repelled by the electrode, and are deposited on the side of the pipe, which interrupts their flight from the chain. The problem in electrical precipitation is to regulate the vertical force so that it is not too great, and to regulate the horizontal force so that it is sufficiently great to form a resultant which will precipitate the particles of dust to the side of the pipe. The principle is not simply one of ionization, and is not one of magnetism. The particle of dust does not stick to the side of the pipe because of the magnetism caused by the corona discharge and gas flow. As a matter of fact, the dust particle sticks to the side of the pipe because it is held there fast by the resultant electrostatic force that is acting upon it throughout the entire period of operation. The voltage that can be impressed on the electrode is limited by the gap between the side of the pipe and the electrode. This has erroneously led to the assumption that the bigger the pipe and the greater the voltage that may be impressed, the stronger the force that may be secured to act horizontally. This is not true, as the force varies inversely as the square of the distance between the object to be precipitated and the electrode; so that, even with higher voltage, the impressed force on the particles may be less than with a lower voltage.

DIVISIONAL COAL STATISTICS FOR 1920.

THERE has been issued by the Mines Department the first part of the annual report on mines and quarries, for the year 1920. This contains statistics of the persons employed, output, and accidents at mines and quarries in the United Kingdom arranged according to the inspection divisions, and is signed by Mr. Thomas H. Mottram, H.M. Chief Inspector of Mines.

The number of persons employed in and about the mines coming within the Coal Mines Act in Great Britain and Ireland during the year 1920, both under and above ground, was 1,248,224, as compared with 1,191,313 in the previous year; the number of mines at work being 2851, against 2843. In addition, there were a certain number of persons engaged at quarries, from which 28,646 tons of coal were taken. The total output of coal from both mines and quarries last year was 229,532,081 tons; the figure for 1919 having been 229,779,517 tons. There were at the mines registered under the Coal Mines Act in the year under review 1060 separate fatal accidents, involving the loss of 1103 lives; the 1089 separate accidents in the previous year having caused the loss of 1118 lives. Of last year's fatalities, 965 occurred underground; and of these 544 were owing to falls of ground. In addition, injuries by non-fatal accidents disabling for more than seven days were caused to 117,302 persons (in 1919 the figure was 117,422). The death-rates in and about mines classed under the Coal Mines Act from all accidents per million tons of mineral raised were 4·6 last year, and 4·67 in 1919. The ratio of mortality from accidents in and about these mines per 1000 persons employed under and above ground was 0·88 for 1920, and 0·94 for 1919.

Cottrell Precipitator Applied to Wood Distillation.

During the meeting at Rochester of the American Chemical Society, Mr. L. F. Hawley described an investigation carried out in connection with the use of the Cottrell electrical precipitator to recover "mists" consisting of very fine drops of liquid pitch in the wood-distillation process. Since the Cottrell system is able to precipitate fine particles of liquids or solids when carried in a stream of gas, it was thought that it should be introduced into this process; and it was therefore connected between the retort and the condenser of a small wood-distillation apparatus. According to "Chemical and Metallurgical Engineering," during the first run the precipitator was heated so that the vapours at the outlets had a temperature of about 160° C. On examining the inside of the precipitator, it was found that a deposit of hard pitch had been built up from the inside surface of the tubes. The temperature of the precipitator was then run near 100° C., to collect the small amount of liquid within the hard pitch. This tar was not very thick even at ordinary temperature, and was sufficiently liquid to drain from the tubes without any difficulty. Although the small-scale experiments have not removed the last traces of pitch, yet they have shown that the general idea of precipitating tar from hot vapour is a possibility.

THE "FAIRWEATHER" RECORDING CALORIMETER.*

This instrument was designed by the late Mr. J. H. Fairweather, of the Brentford Gas Company, not only to meet the requirements of the Gas Regulation Act, but also to provide an accurate and reliable instrument for works purposes. Now that most gas undertakings are, or soon will be, supplying gas on the heat-unit basis of charge, it is a matter of primary importance for efficient administration that due respect be paid to the question of calorific value.

These facts were fully appreciated by Mr. Fairweather, who, in designing his instrument, aimed at one that would, first, give an accurate and reliable record of the total heat value of the gas properly corrected for temperature and pressure conditions, and, secondly, one sufficiently sensitive as to give a record which would readily show a variation of 1 B.Th.U. per cubic foot. On the second point, it may be mentioned that the recording mechanism can be adjusted by a simple device to give a very open scale of (say) 0·05 of an inch per 1 B.Th.U. variation. On the other hand, this scale can be reduced to the probable range of an official test instrument. In either case, the accuracy of the record is maintained.

Careful tests demonstrate that the instrument gives under the conditions of those tests a continuous record within ½ p.ct. of accuracy. Coming to the actual nature of the instrument, which is of the water-flow type, the principal feature is the manner in which the "tabular" correction—*i.e.*, the correction for temperature and pressure conditions—is applied. This tabular correction is applied by the automatic regulation of the water supply; the gas supply being maintained constant. The change in volume of a definite quantity of air enclosed in a vessel, and subjected to the prevailing temperature and pressure conditions, is caused to move a body of oil contained in a specially designed chamber, which oil supports a float device controlling the actual flow of water; the shape of the chamber being so designed as to produce up-and-down movements of the oil and float that will give the correct flow of water. This will be explained more fully later. The apparatus appears to be based upon thoroughly sound theory; and the actual design has been arrived at after a great deal of careful experiment.

Another important feature of the instrument is that the calorimeter itself is an actual Boys calorimeter, of a modified type, which is fitted in such a way that an ordinary Boys test can be easily made at any time to check the accuracy of the record without interfering with the working of the instrument. In the ordinary course, however, it is only necessary to compare the record with the difference in temperature between the hot and cold thermometers of the calorimeter, since the water and gas flows are both accurately controlled; a full check is only necessary periodically. Again, in setting-up the instrument, the pen can be readily set to its proper position on the record by merely observing these thermometers.

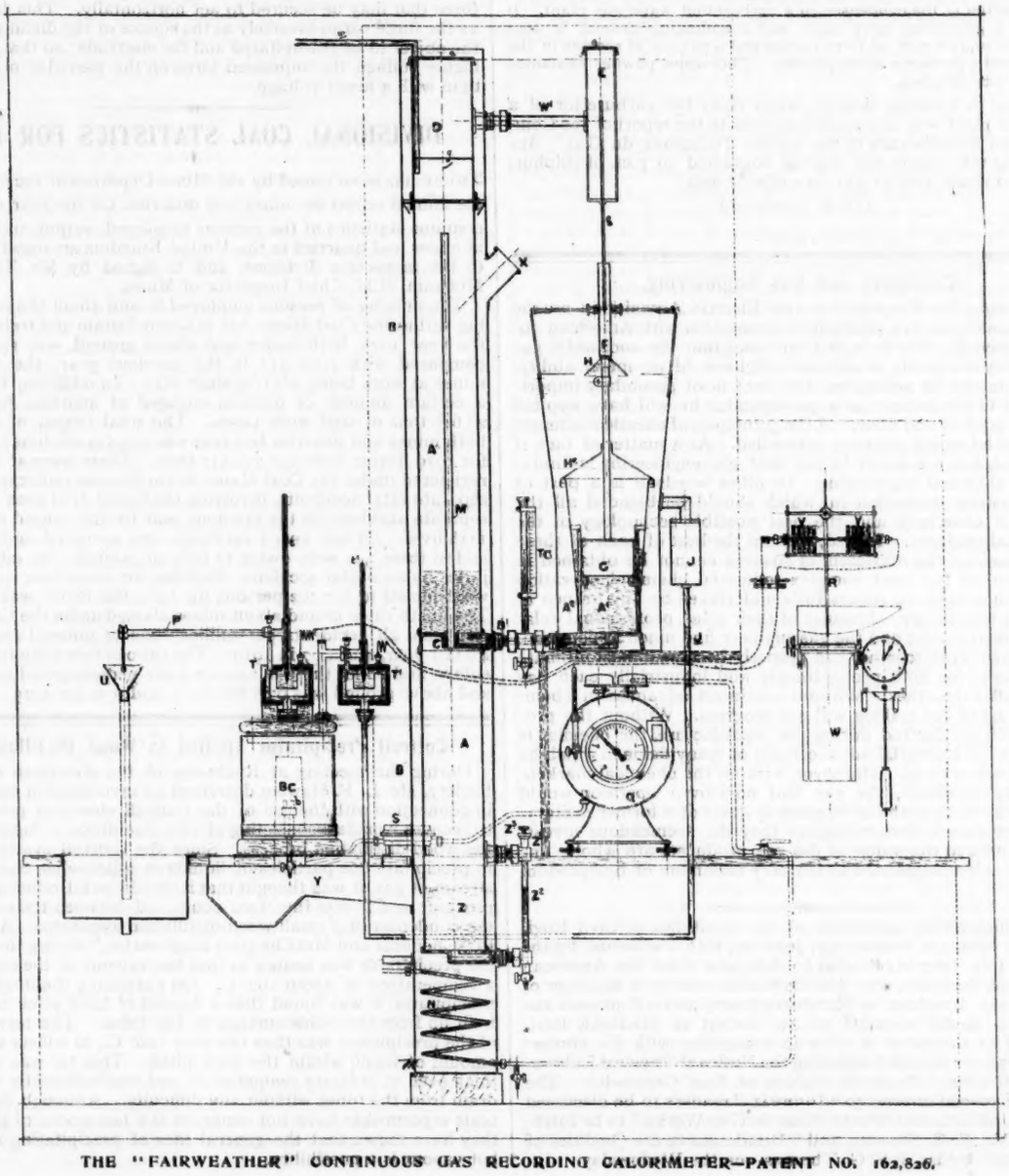
To maintain standard conditions in the instrument, the temperature of the water supply is taken as the standard temperature; both the gas and the air necessary for combustion being brought to this temperature. In addition, the air is also saturated.

The photograph shows the actual make-up of the instrument, while the detailed construction will be understood from the drawing, and will be explained in connection therewith.

Tabular Water Control.

As stated above, the regulation of the water supply is effected by the variation in volume of a standard quantity of air, which is

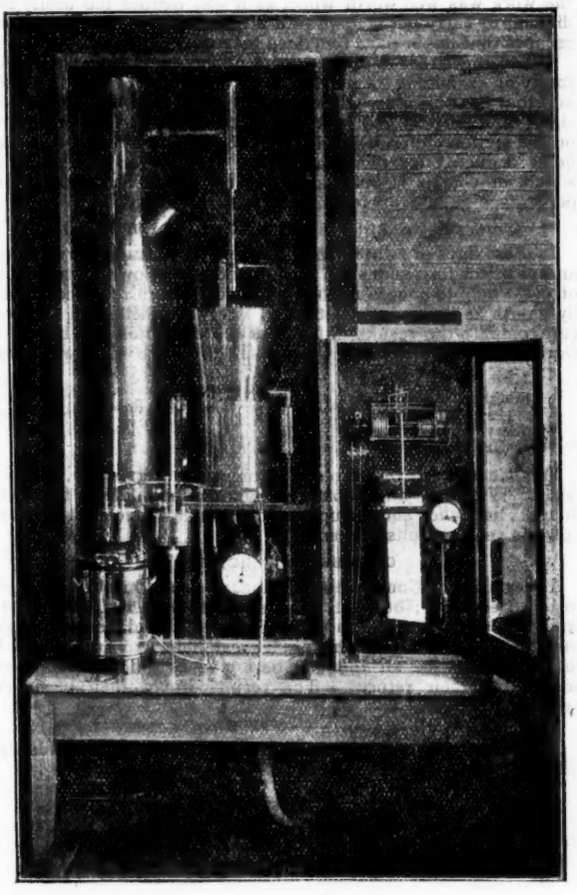
* An illustrated abstract of the patent specification relating to this instrument will be found on pp. 556-7 of last week's issue.—Ed. "G.J."



THE "FAIRWEATHER" CONTINUOUS GAS RECORDING CALORIMETER—PATENT NO. 162,826.

subjected to the water temperature and to atmospheric pressure. Water is supplied by a pipe *w* to an open vessel D connected by a pipe W1 to a second vessel E, from which depends a tube *e* dipping into a cup F carried by a float G, which is supported by oil contained in a float chamber A1. The water overflows the vessel D, which thus acts as a weir, and determines the level of the water in the vessel E, which level is, of course, constant; and the oil level in the vessel A1, which vessel is open to the atmosphere, is modified in accordance with the tabular number so as to move the cup F up or down, and vary the pressure-head acting upon the exit orifice of the pipe *e* in such a manner that the water flow is directly proportional to the tabular number.

Dust covers at *a a*, and the fine gauze filter at *g*, prevent the possibility of a restriction reaching the orifice. The water overflowing the cup F is diverted by a baffle H and cover H2 into a vessel A2 surrounding the chamber A1, and passes thence through the funnel J and pipe *j* to the calorimeter BC. The float G and cup F are guided with a minimum of friction. Movement of the oil within the chamber A1 is effected by the variation in volume of air enclosed within a vessel A, which is connected to the float



A View of the Complete "Fairweather" Apparatus.

chamber by a pipe B1, and is divided by a partition C, which supports the oil at about the level of the chamber A1. The two parts of the vessel A are connected by a pipe M. The vessel D is arranged on top of the vessel A, so that the water overflowing passes down the sides of the vessel A, and brings the air therein to the temperature of the water. Moreover, since the float chamber A1 is open to the atmosphere, the air in the vessel A will be under a pressure equal to that of the atmosphere, slightly modified by the hydrostatic pressure due to the difference between the oil-levels in the vessel A and chamber A1. It will thus be appreciated that changes of atmospheric pressure and of the water temperature will alter the volume of the air within the vessel A, and cause oil to be forced into, or withdrawn from, the float chamber, so altering the level of the float and cup F, and altering the water supply.

The shape of the chamber A1 is specially designed so that the movement of the cup produces a water flow directly proportional to the tabular number corresponding to the atmospheric pressure and the water temperature. The air vessel A is arranged within a casing B. Water is placed in the lower compartment of the vessel A, to adjust accurately the air capacity, and also to moisten the air. This is shown at *Z*. Water is introduced through a valve at *Z*1, and the water level is shown by a gauge glass *Z*2. An air valve at *Z*3 serves for introducing and sealing the air.

In setting-up this part of the instrument, the oil is introduced into the chamber A with the valve *Z*3 open, and the air capacity adjusted by introducing water through the valve *Z*1. Air is then forced into, or withdrawn from, the vessel A through the valve *Z*3, to bring the oil level in the float chamber to the correct height, as indicated by a tabular gauge TG.

Gas and Air Supply.

The gas is passed through a coil N immersed in water in the bottom of the casing B, and then passes through a Parkinson clock-meter Q and anti-fluctuator S to the burner *b*. Air for combustion is delivered to the calorimeter through a closed channel Y connected to the casing B; the air passing into the casing through an inlet X. Consequently, both gas and air are brought to the temperature of the water.

The Calorimeter.

The calorimeter BC is of the Boys pattern, but has, in addition to the ordinary mercury thermometers *t t*1, thermometric air boxes T T1 arranged in the hot and cold water flows; these boxes being connected by fine copper tubing to aneroids V controlling a pen R moving over a record chart W. Any change of temperature of the water alters the pressure of the air within the boxes, and so operates through the aneroids to move the pen. The water flowing through the calorimeter passes to waste through a pipe P and funnel U, which can be readily moved aside to enable the water flow to be measured for check purposes.

It will be observed from the photograph that the meter, mercury thermometers, and funnel U are conveniently placed for an ordinary Boys test to be made periodically, if so desired. However, as the water flow is accurately determined by the tabular device, it is sufficient merely to take the temperature rise as given by the thermometers *t t*1 to check the accuracy of the pen. The temperature rise is a direct measure of the calorific value of the gas, and is converted into the terms of the record chart—B.Th.U. or percentage of declared calorific value—by the use of a simple chart or table placed near the record.

Results.

An instrument installed at the Brentford Gas Company's works, at Brentford, has been running continuously for about nine months. Careful tests have proved the accuracy of the water control; and check tests of the record, not only made upon the instrument itself, but also upon an independent Boys calorimeter, have shown the instrument to be accurate to within ½ p.ct., the differences between the record and the check tests rarely exceeding 3 B.Th.U. As an indication of the range of the instrument, it may be mentioned that the movement of the cup F is about 0·4 of an inch for each 1 p.ct. variation of the tabular number, and that on the record the pen moves about 1·25th of an inch for a variation of 1 B.Th.U. As indicated above, it is possible to give an even more sensitive movement or a less sensitive movement to the pen by a simple adjustment of the recording mechanism.

The Gas Referees have had the "Fairweather" calorimeter under their observation for some time past; and they have no objection to the publication of the following extract from their letter of May 11 last: "The Gas Referees are prepared to give a limited certification of the Fairweather calorimeter for official testings of the gas supplied by the Brentford Gas Company. The certification is liable to cancellation at the end of the year if the instruments prove unsatisfactory for official purposes."

The manufacture and sale of the instrument are in the hands of Messrs. Scientific and Projections, Ltd., Crawford Passage, Farringdon Road, E.C. 1, who will be glad to furnish further information concerning the instrument. Mr. Charles Fairweather, brother of the late Mr. J. H. Fairweather, is Managing-Director of this firm.

Spacing of Chequer Bricks in Water-Gas Apparatus.

Having learned that the United Gas Improvement Company were using a wider spacing than formerly for the chequer bricks in their water-gas machines, the Rochester (N.Y.) Gas and Electric Corporation decided to try the same plan as their own machines came down for repairs. In the first place, the practice was adopted in an effort to use the heavy gas-oils with which gas companies anticipated having to deal; but the change worked so satisfactorily with the usual grades of oil, that it was adopted as regular practice. The chequer bricks in the Rochester Corporation's carburettors and superheaters used to be laid with a 2½-in. space between rows. They are now laid with 4½-in. spaces for the bottom seven courses in the carburettors; and above that 6½ in., 3½ in., and 2½ in. for the lower, middle, and top thirds respectively. The first question was the effect of the change upon the oil efficiency—that is, whether or not the decreased number of bricks would store sufficient heat to crack the gas-oil. In working, no difference in oil efficiencies could be detected. As to the effect on machine capacities, with one machine that had been running at a rating of 4 million c.ft. per day under the old spacing, the chief limiting factor was the air supply; and in this instance a decrease was noted in the pressures through the machine of a little less than 1 in. with the new spacing as compared with the old. But working so closely as they were to the capacity of the blower, there was little, if any, appreciable capacity increase for the machine. With another machine, however, the position was different. This machine was normally rated at 1,300,000 c.ft. per day, though it had been run at 1,500,000 c.ft. With the new spacing, the pressures, for the same running conditions, showed a decrease of approximately 2 in.

WAVERLEY ASSOCIATION OF GAS MANAGERS.

Meeting at Hawick.

The Association held their meeting at Hawick on Thursday of last week, when

Mr. R. J. PHILP, of North Berwick, delivered the following

PRESIDENTIAL ADDRESS.

The coal industry is at the present time in a very serious condition—the coal strike having caused, in many cases, increased expenditure and a very heavy loss in revenue; also the fall in the prices of tar and liquor has occurred at the most inopportune time. It follows that the result of these unfavourable circumstances must be that the consumer will require to pay, in the near future, an increased price for his gas supply.

I do not intend to criticize the cause of the coal strike, which, in my opinion, would not have taken place if a little more of the give-and-take policy had been exercised. I would rather venture to explore the path of future action, and thus safeguard our industry from the serious results of such a strike. This leads one at once to the question of coal storage; and one is compelled to acknowledge that, with the miners making a national instead of a sectional strike, as was customary until a few years ago, the old rule—six weeks' supply—must be departed from, and one of nearer three months' substituted.

Many gas-works, having been built at a time when national strikes were practically unknown, cannot store more than a month's supply; and in numerous cases land cannot be procured adjacent to the works. Such works have therefore a difficult problem to face. I would suggest that in these circumstances ground be obtained as near the works as possible, and a reserve stock put in—great care being taken in the storage. With those works which have ample storage, I would recommend that a large stock be carried. Such a stock of coal certainly costs money—(1) in interest, (2) in deterioration, which causes poorer results in gas and residuals, and (3) in cost of storing and handling. But even when all these drawbacks are taken into account, I think that, until the coal position becomes more settled than it has been during the last few years, it will pay companies and corporations to stock. I do not need to refer to the benefit the general public would receive, or, last but not least, to the lessened worry the manager would have at a time like the one through which we have just passed.

I am well aware that directors and members of gas committees object to money lying idle, as they term it; and this they consider the case when a manager wishes to increase, to a large extent, his stock of coal. On the other hand, such a stock is not to be procured either cheaply or easily in a few days' time, especially when a strike is imminent, as everyone is then in the market. The majority of companies and corporations insure their works against fire and their employees against accident. Why should they not view the coal stock in much the same light—as an insurance against loss by strikes in the mines or on the railway?

THE COAL STRIKE AND INCREASED GAS CONSUMPTION.

One feature noticeable immediately the strike started was the largely increased gas consumption which many, if not all, gas-works experienced. This, in my opinion, showed that the public were anxious to conserve what coal they had, and also that they thought cooking by gas the best way to do so. This is a form of fuel economy which evidently appeals to the average gas consumer, and although it meets with our cordial approval in normal times, it is not an unmixed blessing during the period of a strike. There is no doubt that in a time of national troubles such as we have just passed through, special attention is drawn to the important part gas undertakings play, since they carbonize coal in a scientific way and so conserve fuel for the country's benefit. I have made several inquiries, and I find that few of our friendly rivals have been called upon to distribute more of their energy than usual, which proves that gas is still the popular method of cooking. I may say that my consumption increased during the strike by fully 25 p.ct.

AN OPPORTUNITY FOR COKE.

There is a well-known saying, "Every cloud has a silver lining;" and the coal strike has proved a blessing as regards reducing the stock and raising the price of coke. When the year 1921 dawned, the coke market was in the depths of despondency, large stocks being carried in many works. Later on our English friends introduced their surplus into our country in large quantities, and at a price which rather annoyed the Scottish gas manager, who had, perforce, to reduce his price accordingly. The strike has altered all this, as all gas-works have cleared their surplus fuel; and we trust no English coke will in future find its way over the Border. All classes of fuel being and likely to be in great demand for a considerable time to come, one would imagine the selling price of coke should remain steady for several months. There is no doubt many householders have for the first time used coke as a fuel; and while we cannot expect to sell such quantities as we have done lately for this purpose, I venture to think we shall dispose of a considerable amount.

REDUCING LEAKAGE.

The high price of fuel renders it all the more necessary to reduce the percentage of unaccounted-for gas. In the undertaking I have charge of, the leakage was nearly 18 p.ct. when I took it over. It is now in the neighbourhood of 10 p.ct. Perhaps the means I took to effect this reduction in leakage may be of interest to you.

We have a considerable amount of main to outlying houses or districts; and I made a start on these. The method I adopted was as follows: I bored and tapped five 3-in. holes about a foot apart from each other. Between the first and last hole I coupled a test meter, and inserted a bullock's bladder in the second and fourth, and filled the space between with water through the centre hole. So long as the water remained up, it was impossible for any gas to pass without being indicated by the test meter. I had all the meters shut-off at the stopcocks, and told the consumers not to open them until we sent a man to do so. The main then being dead, we opened the stopcock of the test meter. The results we bracketed into three classes—bad, medium, and good. The bad sections were then examined, usually by piercing the ground over the main with a rod; and it was surprising how often we discovered bad joints and bad connections by this means.

After we discovered a bad escape or a few smaller ones, we retested the section, and so got it into good repair. In some of the larger sections we redivided these into smaller sections. I feel the work was well worth while, as it was neither too costly nor difficult to carry out, and proved a quick means of finding many escapes that might have remained long undiscovered.

When the street is opened for any purpose, I take the opportunity of examining to see if there is any trace of gas. I might add that the police are always willing to bring to my notice any signs of leakage. The leakage is calculated on gas registered on the station meter, less sold and accounted for; no percentage being deducted for temperature and pressure or condensation, which, of course, is quite a legitimate reduction, although the percentage to be deducted may be a matter of opinion.

COST OF MATERIALS AND PRICES OF RESIDUALS.

In these days of swift changes in the cost of materials required and of prices for residuals, I have found the following little table of great help to enable me to get the particulars required month by month at a moment's notice. I keep these lists hung up, and can compare the results either with the estimates for the year's working or with the past year's results. Both are worth watching.

Month.	Tar and Liquor Sold. Tons or Gallons.	Money Received.	Coke Sold. Tons.Cwt.	Money Received.	Average Price per Ton.
January,					
February, &c.					

You can add up every three or six months. Personally, I do the latter. With little alterations this table can be made up for coals bought; and when entered up each month one cannot fail to know how the year's results are tending.

COMMERCIAL SECTION.

As regards our Commercial Section, we had a meeting at Melrose in December; but, unfortunately, the weather all over Scotland was unfavourable, and therefore the attendance was very small. The monthly returns are a great help and guide; and I should like to see all the members give as full particulars as possible in their returns. The results would then be more valuable.

The remainder of our report of the meeting is unavoidably held over until next week.—ED. "G. J."

RAPID DETERMINATION OF WATER IN TAR EMULSIONS.

By W. W. ODELL, of the United States Bureau of Standards, and E. W. THIELE, of the People's Gas Company of Chicago.

[A Paper read before the Illinois Gas Association.]

As a part of the gas-research programme conducted under a co-operative agreement between the Engineering Department of the University of Illinois, the Illinois Geological Survey, and the United States Bureau of Mines, a study has been made of the factors causing or affecting the formation of tar-water emulsions in the process of manufacturing water gas. This investigation was made after the Research Committee of the Illinois Gas Association suggested that the problem was one requiring further study. In conducting this investigation the People's Gas Light and Coke Company co-operated by furnishing the use of one of their laboratories in Chicago, by assigning Mr. E. W. Thiele to take an active part in the work, and by other expressions of interest in the experiments conducted. In the course of this study, it became desirable to have a short and simple method for determining the water content of tar emulsions. This paper presents two such methods which were employed by the writers.

NATURE OF TAR EMULSION.

Tar emulsion is essentially tar in which droplets of water of various sizes are suspended. Strictly speaking, there may be almost any amount of water in the suspension. It would be unusual, however, to speak of a tar with 10 p.ct. of water as an emulsion. On the other hand, the water content may be very large, sometimes as high as 85 p.ct. of the whole. Such an emulsion, in

spite of its being mostly water, will not mix with water, for each water drop is completely surrounded by tar. On the other hand, it may be readily diluted with more tar, or with any of the solvents for tar, since the tar in the emulsion forms a continuous network, to every part of which the solvent can penetrate.

PREVIOUS WORK ON THIS DETERMINATION.

Aside from the various modifications of the distillation methods, there seem to be only two methods which have been used to determine water in tar. Brunkow evaporated a heavy oil-gas tar, containing no light oils, in a drying oven; while Kayser has described a calcium carbide method. It is evident that the former is of very limited application. The latter, though probably accurate, is difficult to carry out, and requires elaborate apparatus.

The standard method of determining the water in tar is, of course, by distillation. In the method of the Barrett Company, as described by Weiss, 200 c.c. of the emulsion are mixed with 200 c.c. of light oils, and distilled to 400° Fahr.; the water being collected and measured. An accuracy of 0·1 p.ct. is claimed for the method. Considering the various sources of error inherent in the plan—such as the sticking of water to the sides of the condenser, and the solubility of water in the oils—this would seem to be the extreme limit. If the mixture shows any considerable tendency to "spit" (froth and boil over), the limit will be much higher. A determination by this method also requires a considerable amount of time and attention on the part of the analyst, as well as a good deal of desk-space.

There is, however, another method which, so far as we are aware, has not been used for tar, but has been much employed for the analogous petroleum emulsions. It is a common practice to determine water in these by adding to them a light gasoline. The mixture is then centrifuged, whereupon the water goes to the bottom, and its volume can be read directly. This method is the same in principle as Method No. 1, described below.

METHOD NO. I.—CENTRIFUGING WITH A HEAVY SOLVENT.

This makes use of the fact that tar emulsions can be mixed with heavy solvents. The tar is completely dissolved in the solvent, so that the water droplets are suspended in a liquid which is not, like tar, of nearly the same specific gravity as water, but is much heavier, and also much thinner than tar. In these circumstances, it is not difficult, upon centrifuging, to bring all the water to the top, where its volume can be easily measured.

The apparatus for carrying out this method can be obtained ready-made, since ordinary milk and cream testing apparatus is very suitable for use in this way. In our work, we employed an ordinary hand centrifuge made for milk testing, and built to accommodate eight bottles at one time. A speed of about 2000 R.P.M. could be attained with this apparatus. The form of bottle used holds about 50 c.c., and has a long, slender, graduated neck. The graduations are numbered—each unit representing 0·2 c.c.

The qualities most desired in a solvent for use in this method are that it should be a fluid of high specific gravity, a good solvent for tar, and immiscible with water. Carbon tetrachloride and carbon bisulphide, of common liquids, best fulfil these conditions. We found the latter to be slightly the better of the two; but its ready inflammability and disagreeable odour led us to prefer the carbon tetrachloride.

With most tars, however, when they are mixed with the solvent and centrifuged for a reasonable time in a hand centrifuge, there is at first sight not a complete separation of tar and water. The upper portion of the neck of the bottle contains clear water; and the body, solvent with tar dissolved in it. But between these is a material which is somewhat like the original emulsion, being dark and rather thick. It has no sharp upper boundary. It varies in amount with different tars, being generally most abundant with the most obstinate emulsions, in which it may occupy more room than the clear water.

On closer inspection, however, it is seen to be lighter in colour than the tar solution below, and to have a sharp lower boundary. If now a glass rod be inserted in the bottle, practically the whole of the material can be drawn out, sticking to the rod. If it is then rubbed on glass, the water in it will separate; and it is then seen that the bulk of the rest, which consists mainly of carbon, is very small. In other words, the whole of the liquid which is above the sharp line between the tar solution and the sludge may be considered, without any great error, as being all water. If greater accuracy is desired, a longer centrifuging will reduce the sludge still further, and even cause it to be eliminated. Warming the solution before centrifuging helps in the separation.

Seen from above, the surface water-carbon bisulphide and water-carbon tetrachloride are convex. In the centrifuge, however, such surfaces are flattened-out, so that the line of demarcation on the neck of the cream bottle represents a flat surface of contact, since the stain will remain even when the meniscus changes shape—if the sludge permits a change of shape. It is, therefore, necessary to allow for this in reading the upper surface—a point intermediate between the upper and lower edges of the meniscus being chosen.

The method, as we carry it out, is as follows: Weigh out 10 grms. of tar emulsion into a cream bottle. Fill the bottle nearly to the neck with carbon tetrachloride, and mix well by shaking carefully. Fill the bottle to the top graduation with carbon tetrachloride and centrifuge. Two or three minutes at 2000 R.P.M. are ample for most determinations. Read the number of divisions occupied by the water, counting all the sludge as water and taking as the upper mark a point halfway between the top and bottom of the upper meniscus. Twice the number of divisions equals the percentage of water by weight. If percentage by volume is desired, take 10 c.c. of emulsion in place of 10 grms.

The cream bottles can be obtained with necks of varying diameters. We made use of 30, 35, and 50 division bottles, according to the amount of water in the tar. There are also obtainable 10-division bottles, called milk bottles. The fewer the number of divisions, the smaller the neck; so that these bottles are more accurate for smaller amounts of water, but the slender neck makes it somewhat difficult to fill them.

In some experiments made with a synthetic tar emulsion prepared from anhydrous tar, carbon, and water, it was found that the results seemed, as might be expected, slightly high; but the differences were within the necessary errors in reading the volume of water. The method, for large amounts of water (say, 75 p.ct.), is accurate within the limit of 1 p.ct. It is more accurate the smaller the amount of water present in the emulsion. It is very evident that this method is more rapid than the distillation method. It is easy to make two determinations by it in less time than it would take to set-up the apparatus for a determination by distillation.

Eight determinations can be made, and the apparatus cleaned, in half-an-hour.

METHOD NO. II.

This method depends on the fact that carbon black has a very strong absorbing power for the oils of which tars are composed. Carbon black is a light, fluffy powder, somewhat similar to lamp-black, made by the imperfect combustion of natural gas. When this is added to oils or tar in proportions depending on the character of the oil, it forms a pasty mass, of the consistency of heavy putty. The amount required to do this with tars is about one-fifth the weight of the tar. The tendency to do this is so strong that, when carbon black is added to a tar emulsion, it will draw the tar, as it were, away from its network around the water, leaving the water drops free to unite and be poured off.

The method of making a determination is very simple. We found a mortar a convenient receptacle in which to perform the operation. Weigh-out into a mortar 100 grms. of the emulsion. Add successive small portions of carbon black, meanwhile mixing well with a spatula until the residue becomes a thick paste, similar to thick putty, pouring off into a graduate the water that separates from time to time. Knead the paste well with a spatula or pestle until no more water separates. The cubic centimetres of water separating represent directly the percentage of water in the original emulsion.

It is evident that the accuracy of this method is greater the larger the amount of water present, since the chief source of error is the water retained in the paste. We found that we could represent this loss very well by adding to the water found 2 p.ct. of the percentage of anhydrous tar. With this correction, the results obtained were very close to the true value. Not enough work was done to determine whether this factor is suitable for all varieties of tar emulsions. Probably each analyst can determine this factor for his particular use. It will be seen that for emulsions of high water content the correction is not of very much importance.

CONCLUSION.

In conclusion, it seems probable that, for the sale of tar and tar emulsion, the methods here proposed can hardly compete with the distillation method—especially as the latter is quite firmly entrenched in contracts. For routine works' analyses, however, where the highest accuracy is not required, these methods will, it is thought, be found very useful, as they require but a small fraction of the time that a distillation demands. Especially is this true of Method No. II. Many laboratories may not find it profitable to invest in a centifuge; but a can of carbon black costs little, and may save time and trouble.

Loughborough Water-Gas Plant.—The Gas Committee recommended, at the last meeting of the Loughborough Town Council, the provision of a duplicate water-gas plant; and it was referred to them to deal with the matter. It was pointed out that the need was urgent; there being the danger of a breakdown at any time with the existing apparatus. The Mayor emphasized the importance of making the additional arrangements. The present plant has been in operation over twenty years, and requires to be thoroughly overhauled.

Meters, Ltd.—In submitting, at the meeting in Manchester tomorrow [Thursday], the accounts of the Company for the year ended March 31, the Directors will report that the trading has resulted in a gross profit of £45,663, which is reduced by general management expenses, Directors' fees, legal charges, expenses on patents, income-tax, and depreciation of buildings, machinery, and plant. A sum of £9299 has been charged to revenue for repairs and renewals. After providing for interest on debenture stock, the net profit amounts to £27,414, which, with £6989 brought forward, makes £34,403, out of which interim dividends, at the rate of 5½ p.ct. per annum upon the preference shares and 5 p.ct. per annum on the ordinary shares, have been paid. The Directors now recommend the payment of further dividends at the rate of 5½ p.ct. per annum upon the preference shares and 12 p.ct. per annum upon the ordinary shares (making the ordinary dividend 8½ p.ct. for the year, less tax), also the payment of a bonus of 4d. per share (free of income-tax) upon the ordinary shares; that the sum of £3000 be added to the reserve fund (making this fund £123,000); and that £2000 be added to the staff benevolent fund (making the fund £4100). This will leave £8825 to be carried forward to next year's accounts, subject to excess profits duty (if any) and corporation profits tax.

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

"Declared" or "Supplied" Calorific Value.

SIR,—In your last issue, Mr. Ibbs throws out a suggestion that gas undertakings, in computing the number of therms sold, should take the actual average calorific value supplied, and not the declared value as the basis of the calculation.

It is not clear whether the figure is intended to be the average of the official or the works tests, but in either case there are serious objections to this course being followed. The declared value having been fixed, it should surely be the duty of the engineers to furnish a gas as near as may be to this standard; and any variation either in an upward or downward direction should be regarded with disfavour.

I am assured that consistency in regard to quality is one of the great *desiderata* under the new system; and with consumers' appliances arranged to accommodate a gas as near as possible to the declared value, it would appear almost as reprehensible to supply in excess as below the standard, though penalties are exacted only in the latter case. The revenue account ought not to be made to suffer for the inexactitudes of the carbonizing department, and if 485 B.Th.U. gas is to be supplied, and not 475, then 485 should be the declared value.

I take this opportunity of urging that, in the preparation of next year's "Field's," a higher figure than the therm should be used as the comparing basis in substitution for the 1000 c.ft. Five therms as a standard may have something to be said in its favour as affording a very approximate equivalent to the 1000 c.ft.; but both the single therm and the five therm should, in my opinion, give place to a ten-therm standard, with the use of which the figure for each therm or 100 therms would at once be seen by a movement of the decimal point. Working with this would give results for 500 B.Th.U. gas exactly double those shown in the present issue at per 1000 c.ft.

I know Mr. Ibbs's partiality for decimals, and am hoping to see the obsolete cubic foot standard eliminated in favour of the "Decatherm."

FRANK DAY, Secretary and Accountant.

South Metropolitan Gas Company,
709, Old Kent Road, S.E., June 13, 1921.

Comparisons of Gas-Making Processes.

SIR,—Published figures of gas-manufacturing results are often misleading, and often omit interest on capital, depreciation, and maintenance. In the case of steaming, these figures and the make of gas per mouthpiece should be given, as well as the consumption of coke used for heating retorts. The other side (as all debatable questions must have two sides, or they would cease to be questions), the publication for one's competitors of dearly-bought confidential information, which arises in the development of all new processes, and to which failures often contribute more than successes, is a matter for serious consideration. For the past twenty years I have been at work, and progress has often been slow and exasperating, until the benefits of the system of complete gasification became realized during the past two years, when rapid progress has been made, and many plants installed.

An output of 55,000 c.ft. of 360 B.Th.U. gas appears to be the most satisfactory and efficient for the plant at present; but arrangements can be made to increase the calorific value of the gas where this is required. It must not be forgotten, however, that the gas from the plant contains a large percentage of methane; and this no doubt has a lot to do with the satisfactory results which it gives in use. The trend of the industry to a lower-grade gas during the past few years has been due to inexorable economic laws, as well as to the fact that the lower quality gas proved itself satisfactory.

Rumours are frequently put in circulation by interested persons or firms, and the plant often suffers at the hands of ignorant or incompetent operators. Indeed, on one occasion I was asked, in confidence, by a director of a gas company, if the plant would work all right if the operator got drunk! In spite of all these adverse influences, and the so-called coal which is often used in it, the plant gains ground daily and the list of firms who have adopted it; and the repeat orders speak for themselves. The results are shown in the balance-sheets of those undertakings who have adopted the plant; and, after all, a commercial business (and the gas industry is nothing if not commercial) depends for its results on its balance-sheet. In many cases the balance-sheet shows that the cost of the complete installation has been saved in less than one year's working. There is an absurd idea in circulation that there is no tar or ammonia recovered from the complete gasification of coal—circulated, no doubt, from interested quarters. In fact, if I were to try to contradict all the rumours which I have heard, I should have at least a week's work in front of me.

June 11, 1921.

C. B. TULLY.
(Per P.P.S.)

Price of Gas at Sunderland.—Owing to the further serious drop in the price of residuals for export, the Directors of the Sunderland Gas Company announce that they have been compelled to increase the price of gas from 2s. 6d. to 4s. per 1000 c.ft., from the next quarterly readings.

Heavy Loss from Inferior Coal.—Mr. Warhurst reported at the last Ulverston Urban Council meeting that during the past month the gas-works had lost £650, which would probably have been to credit if they could have got decent coal. Some £170 was lost in gas, because of the inferior coal; £60 more in wages had to be paid to use an extra retort; £120 more was paid for coal than the price before the dispute; and £280 represented a loss on coke. The coal they had had was rubbish. They were hoping to pull things round, but had decided to consider again the position in regard to the charges made for gas.

REGISTER OF PATENTS.

APPLICATIONS FOR PATENTS.

[Extracted from the "Official Journal" for June 8.]

Nos. 14,912 to 15,542.

BEZANT, B. P.—"Valve for steam, liquids, or gases." No. 15,292.
CLABAUT, C. A.—"Gas-generators." No. 15,248.
COUREYEUR, A. J. F.—See Clabaut, C. A. No. 15,248.
COX, F. J.—"Supply of air to gas combustion apparatus." No. 15,412.
CUNNINGHAM, C. G.—"Production of water gas." No. 15,001.
DEAN, P. W.—"Plant for generation and supply of gas from liquid hydrocarbons." No. 15,359.
DOLLMAN, H.—"Pipe joints." No. 15,187.
EVERED, S.—"Gas-burners." No. 15,286.
EVERED & Co., LTD.—See Evered, S. No. 15,286.
FORRESTER, C.—"Fittings, supports, &c., for incandescent gas-burners." No. 15,423.
HADLEY, W. WRIGHT.—"Gas-fires, gas cooking-stoves, ovens, &c." No. 14,984.
HELPS, G.—"Gas-burners." No. 15,275.
HORSTMANN GEAR CO., LTD.—"Gas-controllers, &c." No. 14,932.
M'LAURIN, R.—"Water-gas plant." No. 15 203.
MANN, EGERTON & Co., LTD.—See Dean, P. W. No. 15,359.
MINE SAFETY APPLIANCES CO.—"Gas-purifying compositions, and their production." No. 15,330.
MOLLER, E.—"Apparatus for separating suspended bodies from gaseous fluids, &c." No. 15,118.
PIRON, E.—"Regenerative coke-ovens." No. 15,363.
RAMBUSH, N. E.—"Gas-burner." No. 15,139.
SAYNER, G. S.—"Atmospheric gas-burners." No. 15,340.
SHIELDS, T.—See Mine Safety Appliances Co. No. 15,330.
SIMON, LTD.—"Ash-conveying plant." No. 15,318.
SMITH, C. C.—"Burners for heating." No. 15,072.
STERN, H.—See Cunningham, C. G. No. 15,001.
STIMEX GAS STOVE CO., LTD.—See Sayner, G. S. No. 15,340.
TULLY, C. B.—"Manufacture of gas for heating and lighting." No. 15,254.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.

Progress of Bills.

The Manchester Corporation (General Powers) Bill: Reported from the Select Committee, with amendments.

The Hamilton Water and Gas Provisional Order Bill, and the Wigan Corporation Bill: Brought from the Commons; read the first time; and referred to the Examiners.

HOUSE OF COMMONS.

Progress of Bills.

The Cardiff Gas Bill, as amended: Considered; read the third time; and passed.

The Hamilton Water and Gas Provisional Order Bill was considered; read the third time; and passed.

The Rotherham Corporation Bill, as amended: Considered; read the third time; and passed.

The Batley Corporation Bill: Reported, with amendments, from the Local Legislation Committee (Section A).

The Waltham Abbey and Cheshunt Gas and Coke Company have withdrawn their petition against the Lee Conservancy Bill.

The Swansea Gas Bill, as amended: Considered; and to be read the third time,

Public Utility Companies (Capital Issues) Act, 1920.

A copy was presented of a report on an application to the Board of Trade under the Act by the Tottenham District Light, Heat, and Power Company.

A Restricted Supply at Devonport.—A notice signed by the Engineer of Devonport Gas-Works (Mr. W. P. Tervet) states that, owing to the inferior quality of coal now available for the manufacture of gas, they have been compelled to restrict the supply. Full pressure will only be given between the hours of 10.30 a.m. and 1 p.m.; and in the event of no immediate improvement in the situation, further curtailment will be necessary.

Gas-Burner Trade Marks.—Before Mr. Justice Russell, sitting in the Chancery Division, Messrs. George Bray & Co., of Leeds, moved for an interlocutory injunction against Messrs. Petrie & Heath, manufacturers' agents, of Upper Ground Street, E.C., to restrain them from selling or offering for sale any gas-burners not of the plaintiffs' manufacture bearing the words "Ceto" or "Deto" or either of them, or any other words similar to, or only colourably differing from, the plaintiffs' trade marks. The defendants consented to the hearing of the motion being treated as the trial of the action; and Mr. Justice Russell granted a perpetual injunction and an inquiry as to damages—the defendants to pay the costs of the action. A similar judgment was obtained against Messrs. W. Brown and Son, of 52, Fore Street, E.C.

MISCELLANEOUS NEWS.

GAS REGULATION ACT APPLICATIONS.

The following further notices have appeared in the "London Gazette" of applications by gas undertakings to the Board of Trade for Orders under the Gas Regulation Act.

Dinnington and District Gas Company, Ltd.

The standard price now authorized in respect of the supply of gas by the undertakers is 4s. per 1000 c.ft.; and the price they have asked the Board of Trade to substitute for this is 1s. 8d. per therm.

Leamington Priors Gas Company.

The maximum prices now authorized in respect of the supply of gas by the undertakers are 4s., 3s. 6d., and 5s. 6d. per 1000 c.ft.; and the prices they have asked the Board of Trade to substitute for these are 1s. 6d., 1s. 6d. and 1s. 9·6d. per therm respectively.

Melksham Gas Light and Coke Company, Ltd.

The standard price now authorized in respect of the supply of gas by the undertakers is 5s. per 1000 c.ft.; and the price they have asked the Board of Trade to substitute for this is 1s. 7d. per therm.

DECLARATIONS OF CALORIFIC POWER.

Gorleston and Southtown Gas Company.—480 B.Th.U. (June 20.)
Plymouth and Stonehouse Gas Light and Coke Company.—425 B.Th.U. (June 24.)
Uxbridge, Wycombe, and District Gas Company.—460 B.Th.U. (June 13.)
Wrexham Gas Company.—450 B.Th.U. (June 21.)

GAS REGULATION ACT ORDERS.

SECTION I.

Frome Gas Company.

After the declared date, the standard price in respect of gas supplied by the undertakers shall be 18·4d. per therm.

For the purpose of ascertaining the authorized rate of dividend for the year in which the declared date occurs, the price charged per 1000 c.ft. during that part of the year (if any) before the declared date shall be rendered into the equivalent price per therm by dividing it by four-and-one-half. (June 8.)

Maidstone Gas Company.

After the declared date, the standard prices in respect of gas supplied by the undertakers shall be 15·8d. per therm and 17·6d. per therm; and these prices shall respectively be substituted for the prices of 3s. 7d. and 4s. 4d. per 1000 c.ft. mentioned in section 24 (alteration of standard price) of the Maidstone Gas Act, 1903.

For the purpose of ascertaining the authorized rate of dividend for the half year in which the declared date occurs, the price charged per 1000 c.ft. during that part of the half year (if any) before the declared date shall be rendered into the equivalent price per therm by dividing it by four-and-four-fifths.

The sum of 1·2d per therm shall be substituted for the sum of 6d. per 1000 c.ft. mentioned in section 6 (as to price of gas in extended limits) of the Maidstone Gas Act, 1907. (June 7.)

Uxbridge, Wycombe, and District Gas Company.

After the declared date, the standard price in respect of gas supplied by the undertakers shall be 18·4d. per therm.

For the purpose of ascertaining the authorized rate of dividend for the half year in which the declared date occurs, the price charged per 1000 c.ft. during that part of the half year (if any) before the declared date shall be rendered into the equivalent price per therm by dividing it by four-and-one-half.

After the declared date, (*a*) the price of 0·8d. per therm shall be substituted for the prices of 6d. and 4d. per 1000 c.ft. mentioned in section 4 (extension of limits of supply) of the Uxbridge Gas Act, 1916; and (*b*) the price of 1·2d. per therm shall be substituted for the price of 6d. per 1000 c.ft. mentioned in section 4 (extension of limits of supply) of the Uxbridge and Wycombe District Gas Act, 1920.

After the declared date, section 56 (for the supply of gas to public lamps) of the Uxbridge Gas Act, 1861, shall be read and construed as if the words "reckoning by the 1000 c.ft." were omitted therefrom, and as if the words "20·2d. per therm" were substituted for the words "5s. per 1000 c.ft."

The undertakers may demand in respect of gas supplied through a prepayment meter a not greater charge than in respect of gas supplied to private consumers within their limits of supply through any other kind of meter or by any other method of supply. (*a*) The charge for the hire of any prepayment meter and fittings to be used therewith shall be a sum of money calculated according to the number of therms supplied, and the maximum rate of charge shall be for a prepayment meter and fittings (including a cooking-stove) 3·6d. per therm; for a prepayment meter and fittings (not including a cooking-stove), 3d. per therm. (*b*) The charge for the hire of a prepayment meter without fittings shall be either a sum of money calculated according to the number of therms supplied (when the maximum rate of charge shall be 1·8d. per therm) or at the rate of 10 p.ct. per annum on the cost of the meter, whichever shall be the higher. (*c*) The said charges shall include the providing, letting, fixing, repairing, and maintenance of the meter and fittings or of the meter (as the case may be), and the cost of collection and other costs incurred by the undertakers in connection therewith. (June 8.)

Woolton Gas Company.

As from the declared date, the maximum price in respect of gas supplied by the undertakers shall be 21·8d. per therm. (June 10.)

BIRMINGHAM CORPORATION GAS DEPARTMENT.

Discussion in the City Council.

There was a long discussion upon the report on the gas undertaking which was presented by the Committee at a meeting on Tuesday of last week of the Birmingham City Council.

GAS COMMITTEE'S REPORT.

Referring to the question of coal supplies, the Committee stated that deliveries of Durham coal ceased about the middle of February last; but they were able to replace the tonnage displaced by more suitable material from other districts, and in anticipation of trouble at the collieries every endeavour was made to accumulate as large a stock as possible. Between the beginning of January and the end of March, the stock of coal was increased by 40,000 tons; and at the commencement of the trouble, the stock of coal in hand was approximately 80,000 tons—sufficient to last about five weeks at the then rate of consumption. When there did not appear to be any likelihood of an early settlement, in order to conserve the coal stocks as far as possible, adjustments were made in the manufacturing arrangements at the gas-works by the closing-down of certain of the coal-gas plant—the make of water gas being increased correspondingly. As from April 14 slight reductions in the pressure of the gas supplied to the city were also made. As time went on, and the stoppage of work at the mines continued, more drastic measures were considered advisable; and by the direction of the Emergency Committee of the Council, the supply of gas was curtailed, on and from May 4, between the hours of 2 p.m. and 4.30 p.m. and 6 p.m. and 9 p.m. Owing to the impossibility of entirely cutting-off the supply, the Committee had to rely upon consumers in the higher districts refraining from the use of gas in these periods; but notwithstanding the appeals and warnings, an output of 6 to 8 million c.ft. of gas per week is recorded during the hours of curtailment.

The Committee deem it advisable to inform the Council that when more stable industrial conditions obtain, it may be necessary again to increase the price of gas. The existing state of affairs, however, makes it extremely difficult to forecast accurately what the position will be after the miners return to work and industry resumes its normal state. At the moment, owing to a variety of conditions, the expenditure of the Department is exceeding the income; but if there should be a reduction in the delivered price of coal—and the Committee think it not unreasonable to anticipate a reduction in the near future—a substantial saving would be effected. A reduction of only 1s. per ton would be equivalent to about £40,000 per annum. It is probable that savings will be effected compared with last year in respect of wages and salaries, gas-oil, and repairs.

All these matters make it practically impossible to foretell what conditions will be in a few months time; and for these reasons the Committee do not recommend any addition to the price of gas at present. They are of opinion that the matter should stand over till they are in a position to make a reliable estimate of the financial situation, when, if necessary, they will bring the matter again to the notice of the Council.

The Committee submitted the statement of accounts for the year ended March 31 last, showing a surplus of £27,232, which has been carried to the special maintenance account.

STATISTICS.

The following are comparative statistics for the years ended March 31, 1920 and 1921:

—	1920.	1921.	Increase.	Decrease.
Gas sold during the year (c.ft.)	11,329,113,800	11,734,970,300	405,856,500 = 3·582 p.ct.	—
New services laid during the year	1,059	2,138	1,079	—
Cooking and heating stoves sold during the year	3,636	3,094	—	542
Total number of cooking and heating stoves on hire at March 31	65,060	69,598	4,538	—
Total number of cookers supplied with prepayment meters at March 31	97,944	98,448	504	—
Total number of prepayment meters fixed or on consumers' premises at March 31	102,690	102,650	—	40

The revenue account showed receipts amounting to £3,699,310, and an expenditure of £3,499,203; a balance of £200,107 being carried to profit and loss account. The quantity of gas sold and used on the works was 11,734,970,300 c.ft., compared with 11,329,113,800 c.ft. the previous year.

THE POSITION EXPLAINED.

Alderman LLOYD, in proposing the adoption of the report, remarked that, in consequence of the difficult coal position, they had had to utilize to the utmost extent the carburetted water-gas plants. Fortunately, there had been no trouble in obtaining the necessary gas-oil; and so far they had been able to reserve sufficient coke for the production of water gas. At the present moment, they had sufficient coal and coke in stock to last for a further two to two-and-a-half weeks. With regard to the price of gas, the Committee thought it desirable to insert a warning in the report; and, in fact, they had considered very seriously whether it was not necessary to ask the Council to authorize at once an increase in the price of gas, up to the 5s. maximum which they were at present able to charge. In the hope, however, that matters would become easier, it had been decided to postpone any

definite recommendation to the Council. As to the accounts, the increased cost of coal was £505,000. This was caused partly by a larger quantity having been carbonized—86,000 tons more than in 1920—but principally by the increased charges due to the advance in railway rates and the greater amount of coal they had had to take from Durham. Expenditure on mains and service-pipes had increased by practically £40,000—work in connection with housing estates being an important factor in these costs. Repairs and renewals of meters had cost £60,000 more. The chief trouble with the automatic meter consumer was the unreliability of the coin attachment, which, since the war, had caused much difficulty. The question had been taken-up seriously with the manufacturers. On the credit side, there had been an increase of £540,518 in sales of gas; the total gas sold having increased by 3½ p.ct. The income from residual products was over £300,000 more; but it was certain such figures would not be realized during the present year. The special maintenance account was the department's only way of providing working capital. They had been able to transfer to it during the year £142,454, but had had to expend £102,000. In closing, he wished to pay a tribute to the members of the staff, who had boldly faced great difficulties, pulled loyally together, and done their utmost to minimize the inconvenience of the coal strike to the citizens of Birmingham.

Mr. E. C. R. MARKS, who seconded, described the report as a melancholy one. Never before in the history of the undertaking had the price of gas been so high and the quality of it so poor; and yet, for the third year in succession, the Committee were unable to contribute anything to the relief of the rates. He asked the Committee to go carefully into the question, with particular regard to the present high yield of gas per ton of coal carbonized and the small proportion of gas-oil used for enrichment, in comparison with the smaller yield of gas and the much larger quantity of oil employed in 1911-12. In the earlier year, they sold the gas at 1s. 10d. per 1000 c.ft., and had a record surplus of £80,000. With the relief now given from the candle-power standard, he suggested the department ought to be able to give better results.

Alderman WILLIAMS said the Committee recognized that the profit they had made was small in proportion to the turnover; but the Council must note the special difficulties under which they had been working. Very heavy burdens in the areas of maintenance of plant and mains were now imposed upon the department.

Mr. ALDERSON congratulated the Committee and their officials on the admirable way in which supplies of gas had been maintained during the present emergency. They had displayed excellent foresight, but for which there would have been a great deal more suffering and distress.

Alderman LLOYD reminded Mr. Marks that there were 530 British thermal units in the coal gas, and only 300 in the blue water gas. It required a considerable amount of oil to bring the latter up to the standard of coal gas. They had kept-up the quality of the gas wonderfully well throughout the strike.

The report was approved.

NOTTINGHAM GAS UNDERTAKING.

A Remunerative Year's Work.

In the present generally unsatisfactory state of Nottingham municipal trading concerns, the report presented at the last meeting of the Corporation on Monday week [*ante*, p. 567] again provided a welcome relief, as affording evidence of continued profitable results of the operations of the gas undertaking, exemplified in sound management. In the decennial period since 1912, under Mr. John Wilkinson's administration as Engineer and General Manager, the gross profits have amounted to £1,161,924, of which no less than £341,000 has been allocated in relief of local rates. This year £30,000 is again being transferred for the purpose, this amount being the same as voted the four preceding years. It is interesting to note, as evidence of sound financial administration, that, *pari passu* with the help which has been afforded in relief of rates, the policy of building-up large reserve funds has been consistently pursued.

The matter of rate-aid was again brought prominently under notice at Monday week's meeting, when Mr. H. FORD questioned the legality of the process whereby the profits of the undertaking are so allocated by the Corporation without the Gas Committee's being first consulted. He pointed out that the income had amounted during the past year to £773,938, and the expenditure to £677,404, leaving a balance of £96,575. There was altogether a disposable balance of £134,829. The Nottingham Corporation Gas Act, 1874, provided that, if in any part of a year the Corporation charge for gas supplied exceeded the rate specified in the schedule to the Nottingham Corporation Gas Amendment Act, 1868, then for that year it should not be lawful for the Corporation to apply, in the manner specified in the seventh clause, money received by them in respect of gas beyond the amount of £5000; and that any surplus of the money received by them beyond this amount should remain in the gas account and be applied towards the reduction of the price of gas. His contention was, therefore, that under the Act £5000 was the utmost which could legally be taken from the gas profits last year towards the relief of rates. He moved as an amendment that the report be referred back, with a recommendation that the amount to be carried forward should be reduced substantially, and that any other available sum should be used to reduce the price of gas.

Mr. H. GOVER FORD (the Chairman of the Finance Committee, and Vice-Chairman of the Gas Committee) pointed out that the policy of applying profits to reduce the rates had been followed ever since the time the undertaking was acquired from the former private Company; and he contended that, in the general interests of the Municipality, it was a right and proper policy to pursue. Some 25 p.ct. of the gas manufactured was sold to consumers outside the city boundaries—to people who not only paid no rates in Nottingham, but who fought recently, when the annexation scheme was under consideration, against the idea of coming into the city to help to bear its burdens. Why should 25 p.ct. of the gas profits be taken away from the City of Nottingham and handed over to these people? The principle would have to be fought-out; but it could not be done upon a report of this kind.

Alderman ALBERT BALL (the Chairman of the Gas Committee), in replying upon the discussion, said it was difficult to understand why some of the councillors wanted to throw away 25 p.ct. of the profits of an undertaking which had cost the City of Nottingham a million of money. He should like to ask Mr. H. Ford whether he knew of any corporation in the country which was selling gas at as low a price as Nottingham.

The amendment was lost by a large majority, and the report adopted.

NELSON CORPORATION GAS DEPARTMENT.

In his second annual report to the Nelson Corporation Gas Committee, Mr. James Mitchell (the Engineer and General Manager) says the expenditure on revenue account during the year ended March 31 was £134,244, while the income was £136,321; the result being a gross profit of £17,542, and a net profit of £2076. For the previous year the net profit was £3044. The average cost of coal in the past year was 39s. 2¾d. per ton, compared with 28s. 11¾d. the previous year; and the wages paid were £32,741, against £23,365.

The quantity of gas made (all coal gas) was 94,622,000 c.ft. at the Nelson works, and 403,524,000 c.ft. at the Brierfield works. This total of 525,146,000 c.ft. compares with 480,465,000 c.ft. a year ago. In the period under review the make of gas per ton was 19,124 c.ft.; the figure for the twelve months before having been 18,053 c.ft. There is now a total of 15,524 consumers—6631 ordinary and 8893 prepayment. The average consumption per ordinary meter was 32,892 c.ft., and per prepayment meter 26,524 c.ft. The vertical retort installation at Brierfield has yielded unprecedented results.

Mr. Mitchell says that "the results of the past year's working have been beyond expectations, taking into account the abnormal prevailing conditions. Notwithstanding the high cost of materials and increased labour charges, the actual expenditure has fallen short of that estimated by £2082; while the income has been £1653 less than that estimated. The net profit is £427 over the sum estimated. The reduced income may be attributed to the inferior quality of coke and tar derived from the class of coal which we were reluctantly compelled to take into store at the Nelson works to meet the winter's supply of gas."

For the current year, the total expenditure is estimated at £132,990, and the income at £143,814, showing an estimated profit of £10,824. These calculations are based on the current prices charged for gas.

BARROW CORPORATION GAS UNDERTAKING.

The annual statement of accounts of the Barrow Corporation gas undertaking was presented to the Town Council meeting on Monday, the 6th inst., by the Chairman of the Committee (Alderman A. Brown). He reviewed the financial results for the year ended March 31 last, and said that, comparing them with the previous year, they had sold 6½ million cubic feet more gas, and the receipts were up by £11,830. The total income had advanced from £111,376 to £139,253. On the other hand, the expenditure had increased from £114,708 to £134,126, chiefly due to advances in the price of coal and materials, and also to extra payments to employees, in accordance with the district awards. After setting aside £8380 for renewals of works and plant, they had a net profit of £5127, against a net loss last year of £3331. The yield of gas per ton of coal had again improved. At Salthouse, with vertical retorts and Yorkshire coal, they had obtained 15,782 c.ft. per ton, against 15,203 c.ft. last year. At Hindpool Road, with the horizontal retorts and Durham coal, they had been able to get their make up to 13,920 c.ft., as compared with 13,091 c.ft. These results, he ventured to say, compared very favourably with other undertakings; and that from the vertical retorts was considerably higher than the guarantee of the makers. Had it not been for the present disturbing coal crisis, and other great difficulties, the Committee would have been justified in proposing a reduction in the price of gas. They were, however, reluctantly obliged to postpone this until more settled times.

The report was approved.

Crediton Gas-Works Shut Down.—In consequence of coal trouble, Crediton has been without gas since Sunday, the 5th inst.

All-Gas Service Cheaper.—The Leyton Housing Committee report that they have considered a letter from the Chief Administrative Officer of the London Housing Board, relative to the gas supply to the houses being erected on the Barclay Estate, intimating that the Board understand that of the 142 houses 47 have been wired for electric light, and that with reference to the balance of 95 houses the Lea Bridge District Gas Company are prepared to undertake to provide gas service for lighting, cooker, and copper at £12 10s. per house, which represents a saving of £5 10s. per house, or a total of £522 10s. on the cost of electricity for lighting, and gas for cooker and copper. The Board consider that this saving warrants adopting an all-gas service for the 95 houses not yet wired for electric light, and request to be informed of the Council's views on the matter, together with particulars as to the terms upon which the wiring contract could be cancelled at 47 houses. The Committee have given instructions for the Board to be informed that, though there is a small initial extra cost in wiring the houses for electric light, there will be an annual saving in general cleaning and decorative repairs to the property consequent on the adoption of this means of lighting, which will within a very short period cover the initial extra cost and ultimately mean a considerable saving. They request consent to the continuance of the work of electrical wiring of the houses.

OTTOMAN GAS COMPANY, LTD.

Accounts from July 1, 1914.

The Ordinary General Meeting of the Company was held, on Tuesday of last week, at the London Offices, Nos. 59 and 60, Gracechurch Street, E.C.—Colonel STEPHENSON R. CLARKE, C.B., in the chair—when there were presented the accounts for the period from July 1, 1914, to Dec. 31 last—the earliest occasion on which it has been possible to do so.

The SECRETARY (Mr. C. J. Daun) read the notice convening the meeting; and the report and accounts were taken as read. The report stated that the Company have a claim against the Imperial Ottoman Government for £53,476. The supply of gas to Smyrna is still being continued, but in circumstances of great difficulty, owing to the very high price of coal during the past year, and the uncertainty of the political situation—the latter difficulty still continuing.

The CHAIRMAN, in moving the adoption of the report and accounts, said the accounts presented covered a period of 6½ years; and he regretted they showed a loss during this period of £44,474. In the event of the Turkish Government meeting their liabilities, this would be converted into a profit of £9000. A statement of the Company's claims had been presented through the proper authorities; but he could not report any immediate prospect of receiving all or part of the money due. This very sad change from the pre-war position of the Company was entirely owing to the results of the war. Having touched on the past, he would turn to the present. This spring the Company flattered themselves that they were surmounting one great obstacle to progress, in being able to obtain coals in England again at a more reasonable price, in which case they would have had the double benefit of good quality as well as reduced cost. Unfortunately, before the first cargo was loaded at the cheaper price, the strike broke out. The Company were, however, very fairly met by the Contractors, who had freely supplied them with Heraclea coal in the past; and they obtained a cargo from them, which appeared to be giving good results. It might interest the shareholders to know that at one time coal had reached the figure of £8 1s. 4d. per ton at the works in Smyrna. Before the war, the last prices were in the neighbourhood of 24s. per ton. Another great drawback had been the terrible state of the Constantinople exchange, which since the armistice had fallen from 110 piastres to as much as 610 to the pound sterling. Now, however, it was somewhat easier—in the neighbourhood of 520 piastres. Still, this was a very miserable figure indeed, and one which, if they were in a position to send money home, they would feel even more than they did at the present moment. However, in consequence of an approaching improvement in the price of coal, and the slight easing in the exchange, the Directors had felt justified in making some reduction in the price of gas, which now stood at about 11s. per 1000 c.ft. for private lighting, with discounts for engines and other special consumers. The Directors earnestly hoped that the prices of fuel and the exchange would later on go further in their favour, and enable them to make additional reductions in the price of gas. In pre-war days the Company's traditional policy was to supply gas at rates which, considering the distance of Smyrna from the sources of supply, were very cheap. This policy was successful; and the Board desired when possible to return to it. The public lighting of the town ceased in April, 1920, owing to the Company being unable to agree with the Greek Authorities upon terms as to the price to be paid for the gas. They were, however, endeavouring by means of the intervention of the British Representative to arrange a contract with the Greek Authorities for the street lighting. So far he regretted they had come to no satisfactory arrangement. To-day, however, the Board heard that they were considering the matter again. The Company were undoubtedly entitled by their concession to the right of public lighting. A good deal of electric light was being supplied, as the Directors contended, illegally by private installations; and against this they had protested. The high price they had been forced to charge for gas had no doubt stimulated these raids on their business; and with cheaper production it was hoped that, even without legal assistance, they might be able to defend themselves. In a letter just received from Mr. Cecil Gandon, he (the Chairman) was pleased to note that the supply of light by some of these electric installations was unsatisfactory, and that the falling-off in the private consumption of gas, which had been very serious, appeared to have been checked. They must hope that, when they were able again to reduce the price of gas, they would gradually recover a good deal of the business they had lost. This loss was very serious, as would be judged from the fact that in 1914 they sold 200,105,400 c.ft., and in 1920 only 82,610,900 c.ft. Owing to bad trade—which had affected the East as much as, or more than, elsewhere—there had been small demand lately for coke or pitch. A little while ago they sold coke at good prices; but with the fall in the value of coal there had, as usual, been a fall in coke; and, unhappily, in this case the shrinkage in the value of coke appeared to be out of proportion to the fall in coal. Smyrna had shared with other countries in having labour difficulties. The Company had special troubles of its own in this connection; the Greek Authorities having instituted conscription, and taken many of the Company's best workmen. This conscription appeared to be contrary to the conditions of the Treaty of Peace, which, however, had not yet been ratified. The work per man per day was regrettably small—only about three-quarters of a pre-war day's work. But little trade was at present being done in Smyrna; and capital for development of business was stated to be practically unprocurable. Some of the facts he had mentioned in dealing with the present position of the Company would enable them to judge that the future was not too rosy. The Company's prosperity depended upon that of Smyrna; and it was difficult to see how that city's trade could recover until its political destiny was assured. By the Treaty of Peace with Turkey, the Government of Smyrna was to be in the hands of the Greeks for five years, when a plebiscite would decide whether the town and district should continue under Greek rule or revert to Turkey. A town with so uncertain a future was not likely to attract capital, and thus be able to recover its former commercial position. When the coal dispute here was settled, and the Directors were able (as they hoped they might be) to come to terms with the Greek Authorities with regard to the public lighting, they would be in a position to judge the future much more clearly. He was sure they would all agree that Mr. Gandon had had to face great responsibilities in times of much difficulty, and would appreciate that the difficulties of the position were due to factors beyond his control. He hoped that this time next year the Board might have a better statement to lay before the shareholders.

The motion was seconded by Mr. STRACHAN C. CLARKE.

Mr. F. W. BROTHERS inquired whether the Company had the right under their concession to supply electric light.

The CHAIRMAN replied that they had the exclusive right to the public lighting, by gas.

The resolution was then carried.

On the proposition of the CHAIRMAN, seconded by Mr. A. F. PHILLIPS, Mr. A. M. Paddon was re-elected a Director.

Mr. PADDON, returning thanks, said that, speaking with a good many years' experience, and from a good many points of view, he never saw a darker outlook than they were confronted with to-day; but they were almost entirely controlled by circumstances upon which they could have no influence. Their fortunes were subordinated to the political situation in Smyrna.

The Auditors (Messrs. T. H. Cooke and F. W. Church) were reappointed, on the motion of Mr. BROTHERS, seconded by Mr. W. H. DAUN.

Mr. COOKE, speaking from a good acquaintance with the conditions of life in Smyrna, said he looked forward to a return of prosperity.

The proceedings closed with a vote of thanks to the Chairman, Directors, and staff, on the proposition of Mr. BROTHERS, seconded by Mr. CHURCH.

STAFFORD CORPORATION GAS ACCOUNTS.

A report on the accounts of the Gas Department submitted at a meeting of the Stafford Town Council on Tuesday of last week showed that the income from sales of gas exceeded that of last year by £12,508, and from residuals by £884, but that there was a decrease of £62 on fittings, leaving a net increase of £13,330. All the items of expenditure, except that of street-lamps, showed an increase; the largest being £9580 for manufacture of gas. The gross increase on trading profits was £2433; and after deducting from the total profits sums set aside for depreciation, loan charges, income-tax, &c., there remained a surplus of £1325—£789 less than last year.

The gas manufactured during the twelve months was 341,009,000 c.ft., an increase of 5 p.ct. The amount accounted for was 325,710,000 c.ft., an increase of 11,858,000 c.ft. The amount unaccounted for was 15,299,743 c.ft., equal to 4·48 p.ct.—the highest recorded in Stafford for the last ten years, and partly due, stated the report, to the large number of meters that had to be repaired, and partly to the fact that, owing to the high cost of labour, the street-mains had not been tested so much as usual.

During the year 19,638 tons of coal, or its equivalent, were carbonized, giving a make per ton of 17,365 c.ft., compared with 15,399 c.ft. last year, and an average of 12,503 c.ft. for the last ten years. This meant that the Corporation saved 7642 tons of coal by their foresight in having installed vertical retorts. Considering that the cost of coal was 42s. 4d. per ton, this saving alone more than paid the interest and sinking fund charges.

It was reported to the Council that the Ministry of Health were prepared to entertain their application for sanction to borrow £16,000 for the provision of purifiers, to the extent of directing a local inquiry to be held on the subject.

PLYMPTON GAS-WORKS OWNERSHIP.

There is a probability of the Plympton Gas Company's undertaking being acquired by the Plymouth and Stonehouse Gas Company; a provisional agreement having been entered into.

For some time past the Plympton Company have experienced considerable difficulties. These mainly arose out of the situation created by the war, and have been increased by the coal troubles of the past two years. The condition of the plant has given much anxiety to the Directors, who recognize that extensive renovations are necessary; and in view of the present cost of labour and materials, and the stringency of the financial market, it was felt that great difficulty would be experienced in carrying out the work. Negotiations have been taking place for some time; the result, it is stated, being that a purchase price equitable to both Companies and advantageous to the public has been arrived at. Application has been made to the Board of Trade for consent to the purchase. The Plympton shareholders have been circularized upon the offer; and it is probable that they will be in favour of acceptance.

The Directors of the Plymouth undertaking say they are confident that, with active propaganda and judicious salesmanship, the Plympton supply will constitute, in the near future, an important and remunerative part of the Company's business. It is probable that the Chairman (Mr. J. H. Ellis) will make a statement on the subject at the annual meeting of the Plymouth and Stonehouse Gas Company on the 21st inst., when a resolution authorizing the Company to exercise further borrowing powers for the purchase money and the outlay required for the working of the Plympton undertaking will be submitted. In a statement on the subject, the Plymouth Company express the hope that, if negotiations are completed, they will be able to supply Plympton consumers with gas at about 5s. per 1000 c.ft., instead of 8s. 9d. as at present.

CURRENT SALES OF GAS PRODUCTS.

The London Market for Tar, Tar Products, and Sulphate.

LONDON, *June* 13.

The tar products market continues inactive, and little business is reported. Pitch is slightly firmer in tone; but makers are not at present anxious to sell for next season's delivery. The demand for road tar continues good. Solvent naphtha is quiet at about 2s. 9d. to 3s. per gallon for 95-160 quality. Pure toluol is about 3s. per gallon.

In sulphate of ammonia, there is nothing fresh to report.

Tar Products in the Provinces.

June 13.

The average values for gas-works products during the week were: Gas-works coal tar, 53s. 6d. to 57s. 6d. Pitch, West Coast—Manchester, 65s. to 67s. 6d.; Liverpool, 65s. to 67s. 6d.; Clyde, 65s. to 67s. 6d. Benzole 90 p.ct. North, 2s. 4d. to 2s. 6d.; crude 65 p.ct. at 120° C., 1s. 11d. to 2s., naked at makers' works; 50-90 p.ct., naked, North, 2s. 3d. to 2s. 4d. Toluol, naked, North, 3s. to 3s. 1½d. nominal. Coal tar crude naphtha in bulk, North, 11½d. to 1s. Solvent naphtha, naked, North, 2s. 3d. to 2s. 4d. Heavy naphtha, North, 2s. 7d. to 2s. 9d. Creosote, in bulk, North, liquid, 8½d. to 8¾d.; salty, 8d. to 8½d. Heavy oils, in bulk, North, 10½d. to 11½d. Carbolic acid, 60 p.ct., 1s. 6d. to 1s. 9d. Naphthalene, £20 to £30; salts, £7 to £9, bags included. Anthracene, "A" quality, 10d. to 1s. per minimum 40 p.ct.; "B" quality, nominal.

FROM A MARKET CORRESPONDENT.

Tar Products.

The continental coal strike has produced a scarcity of supplies in several tar products, which has had the effect of increasing prices in one or two directions. The actual position in pitch remains firm. There is very little to sell and not much demand, although a number of small transactions have taken place for prompt shipment at from 65s. to 70s. per ton. With regard to forward shipment, as much as 75s. per ton has been paid; but sellers are not very anxious to do business at this price. There is very little business in solvent naphtha; but material is scarce, and quoted at about 2s. 6d. per gallon, with heavy naphtha 2d. per gallon less. There is no benzole on offer, and in spite of the notified reduction the price is still maintained. Sellers of 90's still ask 3s. Pure benzole is also scarce at up to 3s. 2d. per gallon. There is nothing doing in carbolic acid; and prices quoted are nominal at just over 1s. 6d. per gallon for crude 60's and 7d. per lb. for 40 p.ct. crystals. Cresylic acid is weak; pale 97/99 being 2s. 3d. and dark 95/97 2s. per gallon. Creosote oil is scarce for prompt delivery at about 8d. per gallon. Naphthalenes are weak; crude being quoted from £7 to £10 and refined about £18 per ton. There has been rather more activity in intermediate products, especially for export. There has been more inquiry for aniline oil and salt, and salicylic acid also remains firm; the tendency still being upward.

Sulphate of Ammonia.

In accordance with anticipation, prices have been considerably reduced, and for home use £18 10s. is being quoted per ton. The export market is irregular, and £16 per ton is as much as can be obtained for this trade.

Full Supply at Dundee.—Dundee is once again enjoying a full supply of gas. The difficulties at the works in regard to American coal have now been so far overcome as to permit of this step being taken.

Price of Gas at Stafford.—The Stafford Town Council last week adopted a recommendation of the Gas Committee to increase the price of gas to quarterly consumers by 6d. per 1000 c.ft. after the June readings had been taken. The proposal was stated to be in consequence of the enhanced price of coal, and of the fact that the inferior quality of the fuel rendered it necessary to use larger quantities. Alderman Young (the Chairman of the Committee) said they were now paying £6 per ton for coal delivered at Stafford.

Increase Rejected at Ripon.—A special meeting of the Ripon City Council was held last week to consider a recommendation of the Gas Committee that the price of gas be increased from 4s. 9d. to 5s. 6d. per 1000 c.ft. Mr. Mills, in presenting the recommendation, said it had been a question whether the Committee should carry on with coal costing nearly £5 per ton, or should close down the works. They decided to carry on; but in view of the loss sustained, an increase in the price of gas became necessary. They estimated the loss to the end of June at £500. A motion to delete the recommendation was carried by eleven votes to three.

Fisheries and River Pollution.—Over sixty representatives of Fishery Boards and Anglers' Associations from all over the United Kingdom took part last week in a conference arranged by the Salmon and Trout Association at the Fishmongers' Hall in London. Among the various speakers, Mr. J. W. Lewis (the Chairman of the Farnham Angling Association) said that in his opinion the effluent from tarred roads was at the top of all river pollution, and that the worst offenders were the County Councils. Representatives of the Board of Agriculture and the Ministry of Health who were present expressed the willingness of their Departments to receive a deputation from the conference. It was accordingly resolved to appoint a representative Committee to approach the two Ministries, and to decide on details of organization for combined action regarding pollution generally.

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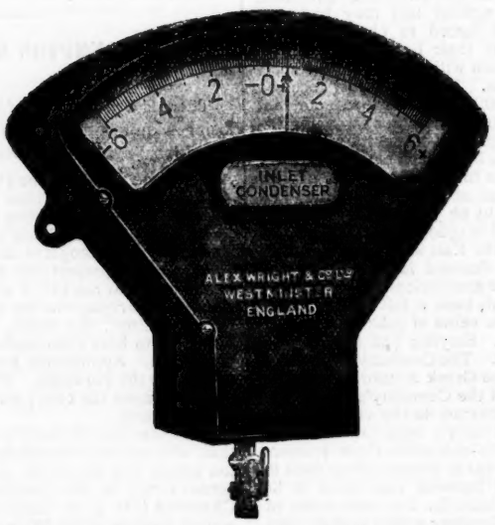
No liquid to evaporate and no levels to adjust.

No glasses to break and nothing to clean.



Direct reading, Open scale, Any range (Pressure, Vacuum, or Combination).

Incorrodible, Accurate, for foul or purified gas.

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Agents: Australia—FYVIE & STEWART, 360, Collins St., Melbourne; Canada—W. P. ROPER, 502, Merchants' Bank Building, Montreal.

Fatality at Stockton.

Early last Thursday morning a distressing accident occurred at the Stockton-on-Tees Corporation Gas-Works. Three labourers were killed outright, two others were very seriously injured, and one of these has since died. The accident occurred in connection with the work of removing old retorts. Ten beds are being demolished to make room for a new system; and as this is required to be completed by October, additional shifts have been employed. Work had proceeded as far as the last set but one. The men were standing about 10 or 12 ft. away from this bed, when the whole collapsed without warning. Five men were buried. When the debris was removed, three men were found to be dead. At the inquest, the yard foreman said he warned the men to keep away from the retort because of the possibility of the wall falling in; but he did this only as a precautionary measure. He thought it safe. He suggested that the vibration of motor vehicles passing along the adjoining street might have caused the accident. Three men who escaped said they were not in the track of the falling masonry. All agreed that they had considered the wall perfectly safe, and one man said that exactly similar walls of the old retorts previously dismantled were so solid that they had to be broken down with iron bars. Mr. W. W. Atley (the Gas Manager) said this was the first accident of the kind he had known. The wall appeared quite good, and he did not think there was need for precautions other than not letting the men work too near. Mr. Greenwood (a representative of Messrs. Drakes, Ltd.) stated that no safer method than that employed could have been adopted. Continual vibration from motor vehicles might have undermined the structure; but there was no history of this. The wall was a substantial structure, and he could not account for the accident. In answer to the Factory Inspector, Mr. Greenwood said there was a side thrust upon the wall from the adjoining part of the retort structure, but not sufficient in any way to cause the accident. He did not consider it necessary that the wall should have been shored up. The jury returned a verdict of "Accidental death" in the four cases, and expressed the opinion that no blame attached to anyone.

Overseas Coal for Scotland.—A French steamer arrived at Leith with 7177 tons of coal for the Edinburgh Corporation Gas-Works. Another steamer of similar tonnage is due to arrive. A steamer with 6000 tons of coal discharged at Aberdeen from America. The Corporation Gas-Works received 4000 tons. Bailie Renfrew, the Convener of the Glasgow Gas Committee, stated that 30,000 tons of Canadian coal had arrived for the Corporation Gas-Works, and 20,000 tons were yet to be delivered. The cost delivered at the gas-works is 66s. 6d. per ton. The present price of procurable home coal at the works is 83s. per ton. The Engineer and Manager (Mr. J. W. M'Lusky) assured him that it was a splendid gas-making coal, and that for bye-products it was better than anything they could now get in this country.

Tar Fuel at Blackburn.—The shortage of coal has led to the introduction at the Greenbank works of the Blackburn Gas Committee of an arrangement by which both boilers are fired with tar fuel. This runs from the storage tank to the boiler, and is sprayed on to a bed of breeze, cinders, &c., which is quite sufficient to generate the requisite steam. It has been found to be much more economical than oil. The system has worked very well; but whether it will be retained when the coal strike is over, is not yet known.

An Offer of French Coke.—Mr. Charles Wood, the Gas Engineer to the Bradford Corporation, as Executive Fuel Officer for the city in the present fuel emergency, has recently received an offer from the English agents of 1000 tons of coke from a gas-works at Paris, at 27s. 6d. per ton, as against an average of 40s. per ton, now the general price in England. The offer, however, was conditional on the buyers providing the whole of the transport facilities; and in view of the great expense of this, the offer has not been accepted by the Committee, especially as there are districts in the South of England where the fuel is much more seriously needed than in Bradford. Compared with many places Bradford is fairly well-placed for fuel.

South African Lighting Association, Ltd.—In presenting at the meeting next Wednesday the accounts for the year 1920, the Directors will report that the price of gas at Port Elizabeth was advanced by 10d. from July 1, and at Grahamstown by 5d. from the same date, making the price the same at both stations. Satisfactory increases in the quantity sold at both places have not altogether compensated for the further rise in the cost of coal, labour, and materials; and inasmuch as the increased price has only been operative for half the period under review, the profits are less than in 1919. The cost of the extensive repairs deferred during the war has proved greater than was anticipated, but has been in part met out of the reserve provided in previous years. No agreement has been come to with the Corporation of Grahamstown as to the provision of works by the Association for a supply of electricity; but negotiations are proceeding with regard to the renewal of the Association's present concession so far as that relates to the supply of gas. An interim dividend at the rate of 4 p.ct. was paid in October last; and, after providing for corporation profits tax, the Directors now recommend the payment of a further 4 p.ct., making 8 p.ct. for the year, such dividend to be subject to the deduction of income-tax at 3s. 6d. in the pound; this being the effective rate after allowing for the amount recovered by the Association in this country in respect of tax paid in South Africa. This dividend will absorb £3600, and leave £5012 to be carried forward. Mr. Andrew L. Don, owing to ill-health, has, to the great regret of the Directors, resigned his seat on the Board. Mr. Don was one of the original Directors of the Association, and has for 32 years rendered valuable assistance. To fill the vacancy thus created, Mr. William Cash, F.C.A., who has been Secretary to the Association since 1891, has been elected a Director, and his son, Mr. William Cash, Junr., has been appointed Secretary.

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SURREY COOKER

An ideal cooker for Housing Scheme requirements. Fitted with high efficiency removable burners, reversible grill, cast or malleable bars; adjustable stand and plate rack if required; spacious oven. Our list gives details of this and other modern cookers.

R. & A. MAIN, LTD.,
EDMONTON, N. 18., FALKIRK, &c.

Without Gas.—Knutsford and some other Cheshire districts are now entirely without gas for lighting or cooking purposes; and consumers have been warned to keep the taps closed. The West Stanley Gas Company gave notice that, owing to lack of coal, they would be unable to supply gas after last Saturday week.

Centenary at Ipswich.—This year the Ipswich Gas Light Company reach the centenary of their inauguration; and the occasion is to be celebrated on Saturday, July 9, at Oak Hill. Belsted Road, on the invitation of the Chairman (the Right Hon. Sir Daniel F. Goddard, P.C., J.P.), and Directors of the Company.

Protection of Gas-Works.—The Gas Committee reported, at the last meeting of the Smethwick Town Council, having accepted, should the necessity arise, the offer of Major Baker of the assistance of the Legion of Frontiersmen for the protection of the gas-works in the event of riot and civil commotion. Mr. Morris twitted the Committee on their report, and moved the deletion of the paragraph, which was carried.

Better Position in Scotland.—Various gas undertakings in Scotland are giving a full pressure of gas to consumers, having obtained supplies of coal. These include Dundee, Perth, and other smaller towns. Greenock has secured 7000 tons of American coal, but is giving supplies to less fortunate gas-works. Glasgow is extending the hours during which gas supplies are available. Consumers are, however, warned that economy must be exercised, or restrictions may be imposed.

Coal Find for the Tipton Gas-Works.—A seam of coal having been discovered on a plot of land at Tipton acquired by the District Council for an extension of the public cemetery, the lessee made application to that authority for permission to work it. A Special Committee of the Council was appointed to investigate the matter. Trial-holes gave good results; and it is expected that the seam, which is about 3 ft. thick, will yield several hundred tons. The Council have given the lessee permission to work the seam, on condition that the output of coal be supplied, at an agreed price, to the gas-works.

STOCK MARKET REPORT.

THE Stock Exchange has had a somewhat chequered week—unchanged only in point of paucity of business—with alterations of dulness almost approaching gloom and more hopeful views of industrial peace being not far off. Prices moved up and down with the tide.

The gilt-edged market on the whole was weaker. Home Government issues were mostly lower, and of the big four Funding alone was unchanged. Friday's prices were: Consols 45½-46, War Loan 87⅜ 87$\frac{15}{16}$, Funding 71½-72, Victory 77⅛ 77¼. Bonds gave way at the close, and Indians showed increased weakness. Corporations were variable. Home Rails, it was noted, held on pretty well in suspended animation, and Canadians and Argentines were better.

The Foreign Market offered no special points; but Brazilian, Chinese, and Japanese were about the best.

Business in the Gas Market was a little more active than in the previous week, especially in the two leading companies; but a goodly number of the less noticeable undertakings were dealt in also. The general characteristic was firmness. Gas Light was certainly a point easier; but South Metropolitan was steady, and Commercial 4 p.ct. rose 2. The Suburban and Provincial group stood well up. Croydon "A" advanced 5, and Newcastle debenture sellers were 1 higher. In the Continentals, Imperial was very quiet and unchanged, and European was firm. Primitiva were little touched.

Bargains done for cash during the week were as follows: On Monday, Gas Light ordinary 55⅜, 56, 56¼, 56⅜, Imperial Continental 133, 136 (and exceptional 106¼, 112½, 118¾), South Metropolitan 67½, 68, 68¾, Croydon debenture 100⅛, 100⅜. On Tuesday, Bournemouth "B" 8¾, 8⅞, Brentford "A" 68, 68½, Brighton and Hove Original 98, 98½, ditto ordinary 71, 71⅛, Gas Light ordinary 55⅛, 55⅜, 56¼, Imperial Continental 133, 134, Primitiva 10s., South Metropolitan 68¼, 68½, 69, Southampton 56⅛, 57. On Wednesday, Alliance and Dublin 42⅜, 42½, 42⅞. Bournemouth "B" 8¾, 8⅞, Brentford "A" 68, Brighton and Hove original 98, Commercial 4 p.ct. 55⅜, Continental Union preference 31, Gas Light ordinary 55⅛, 56, ditto maximum 43, ditto preference 57½, ditto debenture 51, Hong Kong 5⅛, 5¼, Imperial Continental 133, 134, Newcastle 59⅜, Primitiva preference 27s., 28s, South Suburban 59½, Southampton 57¼, Wandsworth "B" 58⅛, Barnet District "D" 68, 68½. On Thursday, Alliance and Dublin 43, 43½, Bournemouth 5 p.ct. 7⅜, 7⅝, 7¾, Brighton and Hove original 99½, 100, Gas Light ordinary 55½, 55⅜, 55⅝, 55¾, 55⅞, ditto maximum 43, ditto preference 58, 58⅛, Imperial Continental 133, 134, 134⅛ (and exceptional 106½), ditto debenture 79½, 80, South Metropolitan 67½, 68⅛, 68½, South Suburban 60, Tottenham "A" 60, Barnet District "B" 90, 90½, ditto "D" 68, 68½, Woking District 5 p.ct. preference "C" 57½. On Friday, Cape Town debenture 57, Chester 65¾, Croydon "A" 130, European 7⅞, Gas Light ordinary 55, 55⅛, 55¼, ditto debenture 51, Imperial Continental 133 (and exceptional 106½, 107½, 133), Primitiva preference 28s., Sheffield "C" 59⅜, South Metropolitan 67¾, 68⅛, Wandsworth "C" 57½, Barnet District "D" 68½.

In the Money Market, the easy conditions which marked the close of the previous week were continued last week, with only a slight tendency now and then to harden; but discount rates maintained firmness throughout. Silver was reported in considerable demand, and reached 35⅜d. The Bank rate is 6½ p.ct., as fixed on April 28.

ANTE-WAR PRICES AND DIVIDENDS, LATEST DIVIDENDS, AND LAST WEEK'S BARGAINS.

Issue.	Share.	When ex-Dividend.	Ante-War Dividend & Bonus.	Last Dividend.	NAME.	Closing Prices, July 30, 1914.	Present Prices.	Lowest and Highest Prices of Bargains.
£			p.c.					
182,049	Stk.	Mar. 11	4	4%	Aldershot 4 p.c. Pref.	...	53—58	..
1,551,868	,,	Apl. 14	2½	3⅛%	Alliance & Dublin Ord.	59—64	39—44	42½—43½
374,000	,,	Jan. 13	4	4%	Do. 4 p.c. Deb.	76—79	47—52	..
280,000	5	Oct. 28	7½	8%	Bombay, Ltd.	5½—6½	4—4½	..
100,000	5	Feb. 25	16	5%	Bournemouth Gas and Water: 5 p.c.	...	7½—8½	7½—7⅝
383,110	10	,,	7	7%	Bournemouth Gas and Water: B 7 p.c.	13—15½	8½—9½	8½—8⅝
115,000	10	,,	6	6/-	Bournemouth Gas and Water: Pref. 6 p.c.	13½—14	7½—8½	..
162,063	—	Dec. 30	—	4%	Bournemouth Gas and Water: 4 p.c. Deb.	...	55—60	..
992,045	Stk.	Feb. 25	14	30/-	Brentford A Consolid.	261—266	65—70	68—68½
734,920	,,	,,	11	26/3	Do. B New	204—209	58—63	...
55,000	,,	,,	5	5%	Do. 5 p.c. Pref.	109—111	68—73	...
221,400	,,	Dec. 15	4	4%	Do. 4 p.c. Deb.	91—93	57—59	...
214,775	,,	Mar. 11	11	7½%	Brighton & Hove Orig.	208—213	95—105	98—100
244,200	,,	,,	8	5⅛%	Do. A Ord. Stk.	154—159	65—75	71—71½
1,287,500	Stk.	July 29	5	5%	Bristol 5 p.c. max.	...	...	..
530,000	20	Mar. 30	12½	10%	British	...	...	..
120,000	Stk.	Dec. 30	4	4%	Do. 4 p.c. Deb. Stk.	44—45	22—24	...
245,771	,,	,,	4	4%	Buenos Aires 4 p.c. Deb.	88—90	50—55	...
100,000	10	May 27	—	6%	Cape Town & Dis., Ltd.	85—87	37—40	...
100,000	10	Apl. 28	—	4½%	Do. 4½ p.c. Pref.	1½—2½	6½—7½*	...
100,000	Stk.	Dec. 30	4½	4½%	Do. 4½ p.c. Deb. Stk.	4—6	4½—5½	...
157,150	,,	Feb. 26	5	5%	Chester 5 p.c. Ord.	70—75	55—60	57
1,513,280	,,	Feb. 25	5/9/4	30/-	Commercial 4 p.c. Stk.	108—110	...	65½
560,000	,,	,,	5½	26/3	Do. 3½ p.c. do.	106—108	55—60	55½
475,000	,,	Dec. 15	3	3%	Do. 3 p.c. Deb. Stk.	103—105	52—57	...
800,000	,,	Dec. 11	4	—	Continental Union Ltd.	69½—71½	42—45	...
200,000	,,	,,	7	—	Do. 7 p.c. Pref.	76—79	20—25	...
51,600	,,	Feb. 5	15	10%	Croydon A 10 p.c.	115—118	30—40	31
278,400	—	,,	12	7%	Croydon B and C 7 p.c.	...	125—135	130
492,270	Stk.	—	6	4½%	Derby Con. Stk.	..	95—105	...
55,000	,,	—	4	4%	Do. Deb. Stk.	123—125	...	...
1,002,180	10	Jan. 29	10	5/0	European, Ltd.	102—104	...	..
16,298,975	Stk.	Feb. 10	4/17/4	30/-	Gas, Light and Coke: 4 p.c. Ord.	17½—18	6½—7½	7½
2,600,000	,,	,,	3½	26/3	Gas, Light and Coke: 3½ p.c. max.	98—102	55—57	55—56½
4,062,235	,,	,,	4	4%	Gas, Light and Coke: 4 p.c. Con. Pref.	76—79	42—45	43
4,674,850	,,	Dec. 15	3	3%	Gas, Light and Coke: 3 p.c. Con. Deb.	96—99	56—59	57½—58½
130,000	,,	Dec. 11	10	10%	Gas, Light and Coke: 10 p.c. Bonds.	72½—74½	48—51	51
82,500	,,	Mar. 11	5	3½%	Hastings & St. L. 5 p.c.	...	...	...
258,740	,,	,,	3½	2⅛%	Do. 3½ p.c.	...	48—53	...
70,000	10	May 12	11	5%†	Hongkong & China, Ltd.	87—89	34—39	...
86,600	Stk.	Mar. 11	9	5⅛%	Hornsey 7 p.c.	16½—16½	5—6	5½—5½
131,000	,,	Mar. 30	7½	3⅛%	Ilford A and C	...	75—85	..
65,780	,,	,,	6½	2⅛%	Do. B	151—154	76—81	...
65,500	,,	Dec. 30	4	4%	Do. 4 p.c. Deb.	115—118	55—60	...
1,976,000	,,	May 27	9	5%†	Imperial Continental	92—94	54—56	...
1,235,000	,,	Feb. 10	3½	3½%	Lea Bridge Ord. 5 p.c.	150—160	130—140*	133—136
335,242	,,	Mar. 30	6½	3⅛%	Liverpool 5 p.c. Ord. A. B.	84—86	76—81	79½—80
2,498,905	,,	Feb. 26	10	37/6	Melbourne 4½ p.c. Deb.	119—121	65—70	...
306,083	,,	June 26	4	4%	Monte Video, Ltd.	211—213	...	...
165,736	,,	Feb. 25	7/5/6	3½%	Newcastle & Gatsh'dCon.	146—148	...	...
75,000	5	June 11	6	3%	Do. 3½ p.c. Deb.	...	...	...
250,000	100	Apl. 1	4½	4½%	North Middlesex 10 p.c.	...	52—57	...
541,920	Stk.	May 27	4	6%	Oriental, Ltd.	98½—99½	59—61	59½
1,875,892	,,	Feb. 25	4½	3⅞%	Ottoman, Ltd.	82—83	50—52	...
529,705	,,	Dec. 30	3½	3½%	Portsea Island, B	...	12½—13½	..
15,000	10	Mar. 11	—	8%	,, ,, 7 p.c.	14—15	7½—8½	...
55,940	10	,,	7/14/0	58%	Primitiva Ord.	115—122	87—92	...
300,000	Stk.	May 12	8	8%	Do. 5 p.c. Pref.	2½	2—3	...
60,000	5	Mar. 26	10	1/-	Do. 4 p.c. Deb.	128—131	65—70	...
60,000	50	Feb. 25	13	7½%	Do. C	118—121	50—55	...
100,000	50	,,	12	6½%	Shrewsbury 5 p.c.	...	...	...
249,980	5	April 29	8	—	South African	10½—11½	9—11	...
499,960	5	June 26	5	—	South Met. Ord.	111—113	67—69	67½—69
521,600	100	June 1	4	4%	Do. Red. Pref.	...	90—92	...
600,000	Stk.	Jan. 27	4	4%	Do. 3 p.c. Deb.	72½—74½	46—49	...
346,198	,,	Dec. 30	4	4%	South Shields Con. Stk.	157—159	85—87	...
150,000	10	Mar. 30	6	6/-	S'th Suburb'n Ord. 5 p.c.	114—116	58—63	59½—60
135,000	50	Jan. 3	5	5%	Do. 5 p.c. Deb. Stk.	116—118	72—77	...
135,000	Stk.	Mar. 30	10	5%	Southampton Ord.	99—102	55—58	56½—57½
209,984	,,	,,	10	4½%	Do. 4 p.c. Deb. Stk.	...	57—59	...
523,500	,,	,,	10	3½%	Tottenham: A 5 p.c.	135—138	57—62	60
133,201	Stk.	Sept. 15	4	4%	Tottenham: B 3½ p.c.	115—117	50—55	...
90,000	10	Sept. 30	9	9%	Tottenham: 4 p.c. Deb.	87—89	53—56	...
6,609,895	Stk.	Feb. 10	5/4/0	5%	Tuscan, Ltd.	5—6	1—2	...
250,000	,,	Jan. 13	—	5%	Do. 5 p.c. Deb. Red.	93—95	45—50	...
1,895,445	,,	,,	3	3%	Tynemouth 5 p.c. max.	108½—109	68—70	...
224,820	,,	Feb. 25	8½	7½%	Wandsworth, Wimbledon, and Epsom—			
1,087,795	,,	,,	6	3½%	Wandsworth A 5 p.c.	151—156	78—83	..
368,837	,,	Dec. 30	5	5%	Do. B 3½ p.c.	129—134	55—60	58½
647,740	,,	May 12	7½	3½%	Do. C	...	55—60	57½
121,275	,,	Dec. 30	4	4%	New Ordinary	...	55—60	...
120,000	,,	Feb. 25	—	3½%	Wimbledon 5 p.c.	117—122	57—62	...
782,275	,,	,,	6	2½%	Epsom 5 p.c.	121—126	55—60	...
181,255	,,	Dec. 15	4	4%	3 p.c. Deb. Stk.	66—69	40—45	...
182,380	10	Dec. 30	5	—				
149,900	10	July 1	5	5%				
236,476	Stk.	Feb. 25	5	3½%				
30,000	,,	Feb. 25	8½	47/6				
255,636	,,	,,	6½	32/6				
108,075	,,	,,	—	33/3				
140,865	,,	,,	—	33/3				
352,000	,,	,,	6½	26/3				
98,000	,,	,,	6½	32/6				
88,416	,,	Dec. 30	3	3%				

* Ex Div. † Next dividend will be at this rate.

Bradford Gas Accounts.—A financial statement presented to the Bradford Gas Committee on Friday showed a loss of £5000 on the year's working, although the Committee had been hoping for a profit of £12,000. It seems a deduction of £17,000 for income-tax on last year's profits had been overlooked by the optimists. This income-tax has swallowed up the profits and left the deficit stated.

Budleigh Salterton and the Therm Basis.—The Budleigh Salterton Urban District Council have decided to lodge an objection against the proposed application of the Gas Company to charge on the therm basis. Mr. Arthur Valon, acting for the Council, said the Company estimated the cost of supply at present at 7s. 11·7d. per 1000 c.ft.; and with a dividend at the pre-war rate, they would need to sell at 8s. 9d. per 1000. The estimate submitted by the Company was grossly excessive. They should be able to sell at something under 6s. per 1000 c.ft., and pay the full pre-war dividend. Adding 6d. for increased costs, the Company should sell for 6s. 6d. per 1000 c.ft., or 1s. 5d. per therm. During the next few years commodities would probably fall in price; and the cost of manufacturing gas would be reduced. The Clerk (Mr. F. G. Hill) said Mr. Valon, after a visit, was satisfied with the condition of the gas-works. It was considered possible that a compromise might be arrived at between the Company's proposal of just over 2s. per therm and Mr. Valon's approximate figure of 1s. 5d. To maintain their position, however, the Council should lodge their objection. Mr. Valon is also acting for the Exmouth Urban Council in their objection to a similar proposal.

Praise for the Sheffield Gas Company.—The "Sheffield Telegraph" says: The restriction of the gas supply in various towns and cities throughout the country has become almost general; but one exception to the rule is Sheffield. Although over sixty days have passed since the strike commenced, the Sheffield Gas Company are still carrying on, and the public have been free from irksome restrictions which are now the lot of neighbouring districts. The resolute way in which the Company have grappled with the problem is certainly to their credit, and especially when one takes into consideration the fact that the supply of coke-oven gas from the Tinsley Park Colliery was cut off at the commencement of the stoppage. Supplies of coke for industrial and household use have only recently been rationed; and the public should be grateful for the foresight shown by the management in maintaining a good supply of gas over such a long and trying period.

Messrs. A. & W. Richards, of No. 37, Walbrook, E.C., are issuing, by order of the Directors, £30,000 of 7½ p.ct. redeemable debenture stock in the North Middlesex Gas Company. The issue price is par; and the stock is to be redeemed at par on July 1, 1931. The capital to be raised by the present issue is required to meet the cost of extensions of the works and plant, rendered necessary by the increasing demand for gas, nearly the whole of which has been carried out, and is now in use. Application for stock should be made not later than 11 o'clock on Thursday, June 23.

NOTICES TO CORRESPONDENTS, ADVERTISERS, AND SUBSCRIBERS.

No notice can be taken of anonymous communications. Whatever is intended for insertion in the "JOURNAL" must be authenticated by the name and address of the writer—not necessarily for publication, but as a proof of good faith.

COPY FOR ADVERTISEMENTS for the "JOURNAL" should be received at the Office NOT LATER than TWELVE O'CLOCK NOON ON TUESDAY, to ensure insertion in the following day's issue.

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Resists 4500° Fahr. Best for Gas-Works.
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Tins for Sale to Consumers.
In Bulk for Works Use.

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CORRESPONDENCE TUITION in GAS ENGINEERING for City and Guilds Institute Exams. (Preliminary and Final). Successful Results. Low Fees.
PENNINGTONS ENGINEERING TUTORS, 254, Oxford Road, MANCHESTER.

SPENCER'S Patent Inclined HURDLE GRIDS.

THE very best Patent Grids for Holding Oxide Lightly.
See Illustrated Advertisement, May 25, p. 450.

TAR WANTED.

BEFORE entering into any arrangement for the DISPOSAL of your Production, it will be to your interest to communicate with
BROWNHILLS CHEMICAL WORKS CO.,
near WALSALL.

J. E. C. LORD (Manchester), Ltd.,
Ship Canal Tar Works, Weaste, Manchester.
Pitch, Creosote, Benzols, Toluol, Naphtha, Pyridine, all kinds of Cresylic Acid, Carbolic Acid, Sulphate of Ammonia, &c.

ROBERT DEMPSTER & SONS, Ltd., ELLAND, Gas Engineers and Contractors for CARBONIZING PLANTS on Horizontal or Vertical Principles, and Stoking Machinery. HANDLING INSTALLATIONS, including Coal Breaking, Elevating, Conveying Plants and Coke Screening, Storing and Telpherage Plants. PURIFICATION.—All Branches of Wet and Dry Purification. STORAGE.—Gasholders, and all forms of Gas Apparatus. Wire: "DEMPSTER, ELLAND." 'Phones: ELLAND 961, 262, 968.

FIRTH BLAKELEY, SONS, & CO., LIMITED, 15, Park Row, Leeds. GAS-WORKS EXTENSIONS. When requiring Alterations or Additions to your Plant, please communicate with us before placing your orders. Gas Apparatus, Coke-Oven Plant, and Structural Steel Work our Specialities. Satisfaction guaranteed. Phone, 22,579 Leeds.

HIGH-GRADE Bye-Product Coal, American, quoted c.i.f. Full Analytical Particulars on Application.

ROLLIN & SONS, 1, St. Nicholas Buildings, NEWCASTLE-ON-TYNE.

NATIONAL ASSOCIATION OF TECHNICAL GAS OFFICIALS.

Head Office:—Temple Courts, 55, Temple Row, BIRMINGHAM.

Full particulars for membership, &c., can be obtained from the General Secretary.

APPOINTMENTS, &c., VACANT.

WHEN Filling Vacancies, please REMEMBER THE CLAIM OF THE EX-SERVICE MAN, who, other Qualifications being equal, has the FIRST CALL ON YOUR CONSIDERATION.

CONSULTING ENGINEER WANTED.

THE Gas Committee of the Clonmel Corporation require the Services of a Qualified ENGINEER to Advise the Committee generally in connection with their Gas Undertaking.

One competent to advise in connection with Electric Lighting, &c., preferred.

Applicants to state Terms.

Applications, addressed to the undersigned, to be Delivered on or before the 29th inst.

R. KNEESHAW, Secretary and Manager.

Gas-Works, Clonmel, June 3, 1921.

CORPORATION OF GREENOCK.

(GAS DEPARTMENT.)

WANTED — An Assistant Works Manager, with a thorough Practical Knowledge of Gas-Works Routine. Experience with Vertical Retorts, Water-Gas Plant, and the Manufacture of Residuals a necessary accomplishment. Salary, £350 per Annum, subject to reduction as the cost of living is lowered.

Applications, stating Age, Experience, and Qualifications, to be lodged with ANDREW NIMMO, Esq., Town Clerk, GREENOCK, on or before Wednesday, the 22nd of June.

WANTED—Works Foreman for Small Gas-Works (4½ Millions). Must be a good Stoker, used to Gas Engine and Exhauster, and able to Lay Mains and Services. Assistance given in Winter Months. House, Coal, and Gas provided. Permanent situation for suitable man.

State Age, Wages required, and send *copies* of Testimonials to the SECRETARY, Gas Company, LOSTWITHIEL, CORNWALL.

WANTED — First-Class Foreman MAINLAYER. Must have had Experience with Large Mains, Services, &c., both Inside and Outside Gas-Works.

Apply, stating Age, Experience, and Wages required, to VINCENT HUGHES, Engineer, GAS-WORKS, SMETHWICK.

WANTED—Carbonizing Shift Fore- MAN, experienced with Inclined Retorts and Water-Gas Plants, for West London Gas-Works.

Apply, by letter, giving full Particulars, to No. 7046 care of Mr. KING, 11, Bolt Court, FLEET STREET, E.C. 4.

PLANT, &c., FOR SALE & WANTED.

GAS ENGINEERS AND MANAGERS.

LIST of Modern Gas Plant just issued Copy willingly sent on application.

This comprises Retort Mountings, Condensers, Washers, Scrubbers, Purifiers, Gasholders, Exhausters, and Sundries. Complete Installations, Renewals, and Extensions.

It will pay you to ask us to quote.

FIRTH BLAKELEY, SONS, AND CO., LTD., CHURCH FENTON, *via* LEEDS.

FOR SALE—Ammoniacal Still, 4 ft. diameter by 14 ft. 10 in., for the Production of Three Tons of Sulphate of Ammonia per Twenty-four Hours.

Can be Inspected at the Reading Gas-Works.

For Further Particulars apply to the ENGINEER and MANAGER.

FOR SALE—Sand-Blast Plant, by Tilghman, complete with Compressor, &c., Suitable for Cleaning Gas Stoves. Also

Two BOILER TANKS, 20 ft. by 6 ft., for Oil or Benzine Storage. £85 each.

Electric 10-Ton LIGHT RAILWAY TRACTOR, 2 ft. Gauge, complete with Charging Dynamo and Switchboard.

Particulars and Prices on Application to HAMMOND AND BOTTOMLEY, 83, Mackenzie Street, SLOUGH. 'Phone 272.

FOR SALE—Two Beale Type Belt- Driven EXHAUSTERS, by G. Waller & Co., capacity about 20,000 c.ft. per hour each, size 22 in. by 22 in.; complete with 9 in. Disc Valves. Require thorough Overhaul.

Also one Horizontal STEAM-ENGINE, 9 in. by 21 in., with heavy Fly Wheel 6 ft. 8 in. diam.; Belt, Pulley, and outer Bearing, also Countershaft and Pulleys. What offers?

Address the GENERAL MANAGER, GAS-WORKS, COLCHESTER.

FOR SALE—Second-Hand Cornish BOILER, in Good Condition, 5 ft. by 20 ft., complete with all Fittings and Mountings, Steam Dome, and almost new Wilton Furnace. Insured at 80 lbs. pressure.

Address the GENERAL MANAGER, GAS-WORKS, COLCHESTER.

THE Brechin Gas Company, Ltd., have the following PLANT FOR SALE, viz.:

HYDRAULIC MAIN, in Four Sections, to suit Three Ovens of Six and Two Ovens of Four Retorts (Hislop's Setting), in Excellent Condition.

18 RETORT MOUTHPIECES (Tangye), to suit 22 in. by 14 in. Retorts.

26 ASCENSION and DIP PIPES, 7 in. to 6 in.

6 18 ft. TIE RODS.

5 PRODUCER (Hislop) FRONT PLATES, complete with Doors.

One 10 in. Bryan Donkin MAIN SEAL VALVE and One 4 in. TAR VALVE, with 4 in. Pipes and Connections.

28 ft. of 18-in. C.I. PIPES and One 18-in. Branch 5 ft. 6 in. long.

Two 22-in. by 14 in. by 9 ft. 3 in. Glenboig Fire Clay Retorts.

Offers for above all f.o.r. Brechin Station.

Also—

Two Water Lute PURIFIERS, 6 ft. 6 in. by 4 ft. 6 in., with Two Four-way Valves, Pipes, and Connections (6 in.) and LIFTING APPARATUS.

TOWER SCRUBBER, 14 ft. by 3 ft., with 6-in. Bye-Pass Valve.

TAR CHEST, 2 ft. 6 in. by 3 ft. 6 in. by 1 ft. 6 in. and Set of CONDENSERS and RETORT-BENCH MOUNTINGS for Six Retorts, 21 in. by 15 in.

These are lying in Edzell Gas-Works, and Purchaser will require to Dismantle and Load on Railway.

Offers to be sent to the undersigned on or before the 22nd inst.

ALLAN REID, Manager.

Gas-Works, Brechin, June 8, 1921.

RAILWAY Tank Wagons for Disposal, Various Types, specially suitable for Oil, Inflammable Liquids, also Acids.

Would prospective buyers please state their Requirements.

BROTHERTON AND CO., LTD., LEEDS.

CONTRACTS OPEN.

LOUGHBOROUGH CORPORATION.

(GAS DEPARTMENT.)

TENDERS FOR TAR AND AMMONIACAL LIQUOR.

THE Gas Committee of the Lough- borough Corporation invite TENDERS for the Purchase of the Surplus TAR and AMMONIACAL LIQUOR made at their works during the Twelve Months from the 1st of July, 1921, to the 30th of June, 1922.

Estimated amount of Tar, 500 Tons; Liquor, 1000 Tons.

The Contractor to state price for Liquor at 5° Twaddel, and per Ton extra for every ½° above 5°.

The Corporation to Deliver both Tar and Liquor either into Contractor's Boats at Canal Wharf or into Contractor's Tanks at Midland, Great Central, or L. & N.W. Stations, Loughborough.

Tenders to be endorsed "Tenders for Tar and Liquor" and addressed and Delivered to H. Perkins, Esq., Town Clerk, Loughborough, not later than Thursday, the 30th of June next.

The Committee do not bind themselves to accept the highest or any Tender.

EDWARD ONIONS, Engineer and Manager.

Loughborough, June 10, 1921.

BOROUGH OF BEVERLEY.

(GAS DEPARTMENT.)

TENDERS FOR STEAM-BOILER, &c.

THE Gas Committee are prepared to receive TENDERS for the following work:—

One "Lancashire" STEAM-BOILER, 28 ft. by 7 ft. long.

Three Forced-Draught FURNACES for Steam-Boilers.

Erection of a SEATING for two "Lancashire" Boilers.

COVERING of STEAM PIPING and BOILERS.

TAR, LIQUOR, and WATER PUMPS.

Copies of Specifications and General Conditions can be obtained and Plans Inspected, and further Particulars obtained, on Application to Mr. J. D. Keillor, Gas-Works, Hawick, Scotland.

Sealed Tenders, endorsed "Gas-Works Plant," to be Delivered to the undersigned not later than the 20th of June, 1921.

CECIL H. WALKER, Town Clerk.

Town Clerk's Office, 81, Lairgate, Beverley, June 8, 1921.

CITY OF LEEDS.

(GAS DEPARTMENT.)

THE Gas Committee are prepared to receive TENDERS for the Supply of—

ORDINARY and PREPAYMENT DRY GAS METERS.
CAST-IRON PIPES.
RETORT CASTINGS.

Specifications and Form of Tender may be obtained from the undersigned.

Sealed Tenders, suitably endorsed, addressed to the Town Clerk, 11, Park Square, Leeds, to be Delivered not later than Thursday, the 23rd inst.

The Committee do not bind themselves to accept the lowest or any Tender.

C. S. SHAPLEY, Engineer and General Manager.

Gas Offices, Market Hall, Leeds, June 4, 1921.

RIPLEY GAS COMPANY LTD. RIPLEY, DERBYS.

TAR AND LIQUOR CONTRACT.

THE Company invite Tenders for the Purchase of the Surplus TAR and LIQUOR produced at their Works from July 1, 1921, to June 30, 1922.

Approximate quantities: 300 tons Tar; 500 tons Liquor, into Buyers' Tank Wagons, at Ripley, Midland Railway.

Tenders to be Delivered at the Company's Offices, Nottingham Road, Ripley, Derbys., not later than Wednesday, June 22, 1921.

WILLIAM HARDING, Manager.

AUDLEY URBAN DISTRICT COUNCIL.

GAS-MAINS.

THE above Council invite Tenders for the Supply of the following WELDLESS STEEL GAS-MAINS, Wrapped and Coated, and the necessary SPECIALS:

1272 yards of 12 in. by 1 S.W.G.
1100 yards of 6 in. by 7 S.W.G.

The 12 in. and 6 in. Mains to be supplied in lengths averaging not less than 25 ft. and 28 ft. respectively.

The Tubes and Specials will be subject to Inspection at the Contractor's works by Mr. J. Mottram, Engineer and Manager, Gas-Works, Audley, from whom further Particulars may be obtained.

Tenders, endorsed "Gas-Mains," to be sent to me not later than the 21st inst,

JOHN J. NELSON, Clerk to the Council.

Kidsgrove, Staffs., June 7, 1921.

STOCKS AND SHARES.

By Order of the Directors.

New Issue of Capital.

NORTH MIDDLESEX GAS COMPANY.

(Incorporated by Special Act of Parliament, 1895.)

MESSRS. A. & W. RICHARDS are Instructed to issue

£30,000 7½ PER CENT. REDEEMABLE DEBENTURE STOCK.

Issue Price, Par.

To be Redeemed at Par on the 1st of July, 1931.

The Net Revenue of the Company for last year was £17,020, and as the Interest on the Loan Capital, including that now to be issued, only requires £3624, it is thoroughly well secured.

The Company's Statutory area includes the London-Suburban districts of Finchley, Hendon, Mill Hill, and Golders Green.

The consumption of Gas last year was nearly 450 Million Cubic Feet, as compared with 284 Millions in 1913. The consumers at present supplied number over 12,000.

Prospectus and Form of Application, which should be sent in by 11 o'clock on Thursday, June 23, 1921, may be obtained of MESSRS. A. & W. RICHARDS, 37, WALBROOK, LONDON, E.C. 4. Telephone: City 3833.